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PROGRESS REPORTS FROM
EXPERIMENT STATIONS
SEASON 1946-1947

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SEASON 1947-1948

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[Included by courtesy of the Queensland Government.]

QUEENSLAND.

REGIONAL EXPERIMENTAL STATION, BILOELA.

PROGRESS REPORT FOR THE SEASON 1946-47.

BY

W. G. WELLS.

INTRODUCTION.

The progress report on the cotton investigations conducted at this Experiment Station during the 1946-47 season has been prepared from the reports submitted by the same officers as those who were responsible for carrying out the work in the previous season.

This past season may be classed as being one of the worst that has been experienced at this centre. A long period of dry weather prevailed from early February, 1946, until mid-October, when a storm allowed of the final preparation of the seed beds. Another storm in late October enabled some of the cotton experiments to be planted. This was followed by a good rain group in mid-November which provided sufficient moisture for the completion of the season's planting programme. An extraordinary outbreak of the web spinner caterpillar destroyed much of the stand in some of the experiments in the seedling stage, and mutilated the plants in most of the remaining experiments so badly that a nearly ideal season was required from then on to produce much of a crop. Unfortunately very wet conditions during February and the first half of March stimulated the growth of a sappy type of plant which reacted most severely to the very dry conditions that prevailed for the rest of the season. Consequently only light yields were obtained on the rain-grown cotton and many experiments were of no value.

Table I presents the more pertinent data for the season.

TABLE I.
CROPPING DATA.

<i>Crop.</i>	<i>Planting Dates.</i>	<i>Picking Dates.</i>	<i>Legal Close Season.</i>	<i>Rainfall 30/6/46-30/6/47.</i>	<i>Mean Temperature Oct. to Nov. inclusive.</i>	<i>Mean Yield Lint per Acre.</i>
Rain-grown cotton ...	28/10/46 16/11/46	18th March until end of August.	Nil	26.34 ins.	Max. 86.9°F. Min. 61.6°F.	25.4 acres. 112 lb.
Irrigated cotton ...	29/30/46		Nil	+ 3 to 4 applica- tions of 3 inches per acre.	Max. 86.9°F. Min. 61.6°F.	8.5 acres. 505 lb.

METEOROLOGY.

The total rainfall for the 12 months ending 30th June, 1947, amounted to 26.34 inches compared with the mean for 1924-47 of 27.56 inches. The total illustrates the inadequacy of the seasonal

total rainfall data to describe seasonal growing conditions—the excess of 6.79 inches over normal for the February and March rainfall mostly accounting for the approximation to the previous mean for the life of the Station. Table II is presented to give a clearer idea of the irregular distribution of the season's rainfall.

TABLE II.
SEASONAL RAINFALL DISTRIBUTION.
(in inches.)

	June— Sept.	Oct.— Dec.	Jan.— March.	April— May.	Seasonal Total.	No. of Wet Days
1946-47	0.72	8.10	16.19	1.36	26.37	72.00
Mean 1924-47	4.54	8.28	11.72	3.26	27.80	75.30

The intensity of the season's rainfall very closely approximated to the means of the last nine seasons for which data are available. The total erosive rainfall for the season (over 0.7 inches per hour) amounted to 12.84 inches or 48.8 per cent. of the total. Maximum screen temperatures as a whole were higher than the means for the last 22 years, but the minimum screen readings depicted a cold late winter, followed by above normal nights during mid-summer and in May, but exceptionally cold nights in June when many killing frosts were experienced.

AGRICULTURAL PRACTICES.

The combination of the effects of the severe attack by the web spinner caterpillar and the very dry autumn so severely affected most rain-grown experiments as to make the results of little interest or value. A scarcity of pickers caused such a delay in the harvesting of some of the experiments that the yields were further affected by the intense drying out of the seed cotton before it could be picked. No experiments dealing with agricultural practices are therefore reported.

Defoliation Experiments.—Exploratory investigations in chemical defoliation of cotton plants prior to their crops' being harvested were continued this season. Applications of aero-defoliant dust obtained from the United States of America proved to be much more effective than either locally made cyanamid or a combination of equal parts of this cyanamid and sodium fluosilicate plus an equivalent amount of pyrophyllite as a diluent to obtain better distribution of the coarsely ground cyanamid. Large plants with a very dense foliage that had been grown with supplementary irrigation were defoliated within eight days after the aero defoliant was applied—only a few small axillary leaves remaining. The local cyanamid removed only slightly over 50 per cent. of the leaves while the substitution in part of the sodium fluosilicate greatly reduced the efficiency of the cyanamid.

When these treatments were applied to rain-grown cotton the plant reaction was not so marked and two days longer were required before leaf fall commenced. It is hoped to carry out the investigations on a more extensive scale in the coming season.

Soil Structure Studies.—Investigations were continued on the soil structure, as measured by the relative percentages of water-stable aggregates larger than 0.7 mm., in areas under various cultural treatments. In the main series of plots designed to compare continuous cotton growing with rotations of cotton and various sorghum crops, a comprehensive sampling of the soil did not indicate that a gain in size of structure of the soil had been obtained by use of rotations. In another series it was found that there was a definite tendency for the plots which had been under Rhodes grass for four years to have a greater percentage of large aggregates (over 0.7 mm.) than did the companionate areas which had previously been under either Sudan grass, or two or three years of Rhodes grass. Sampling of a sandy clay soil on which winter wheat had been repeatedly grown for upwards of 20 years indicated that the 7–12 inch layer of soil had a much greater percentage of large aggregates (over 0.7 mm.) than had the 0–6 inch layer. These latter soils are becoming markedly less permeable to the summer rainfall, and will therefore be planted to Rhodes grass pasture for several years.

IRRIGATION INVESTIGATIONS.

The investigations in cotton irrigation consisted of a repetition of the time and rate of spray irrigation experiment conducted in the previous season, a trial of the major commercial varieties suitable for the district, following three different cropping rotations, and a strain trial.

Time and Rate of Spray Irrigation Experiment.—This experiment was a repetition of the one reported upon in the 1945–46 Progress Report. The outstanding feature of the experiment this season was that the treatments which received the “normal” irrigation timetable (i.e., only a 3-inch pre-planting watering until early January, when either a 3-inch or 6-inch watering was applied) showed signs of experiencing considerable water stress before the second watering was applied at the regular time. This was reflected in the first picking, neither treatment having sufficient cotton open to warrant harvesting. The leading treatment at the first picking was that which received a 3-inch pre-planting watering and a similar watering in mid-December. At the second picking, however, the two treatments omitted from the first picking outyielded all others by nearly 100 per cent., with the previous leading treatment an outstanding last. Little difference was obtained between any treatments in the final picking. The total yields for the season indicated that the two treatments which received their second watering of 3 inches 48 days after a similar pre-planting watering and then further 3-inch waterings in the first and third weeks of January, out-yielded all others. The main “normal” treatment yielded 490 lb. lint per acre compared with 573 lb. for the leading treatment for the season. The results confirm last season’s findings that unless at planting time the subsoils are wet to sufficient depth to supply the plants’ requirements until the first week in January, there is danger that the development of the crop will be checked if the

December rainfall is inadequate, unless an irrigation is applied in time to prevent the plants experiencing stress conditions. When to apply such an irrigation to the best advantage still requires further investigation, and the experiment will be continued in the coming season.

Combined Varietal and Rotation Experiment.—The irrigation area, although of a more loamy soil type than most areas of the experiment station, after six years of repeated cropping with cotton from the virgin condition exhibited signs of the deterioration in permeability that has characterized the old cultivations on the heavier soils of this centre. Accordingly during this past season seven varieties of cotton were tested under each of the following conditions—(a) old cultivation where wheat had followed cotton, (b) the second season of cotton after three years of Rhodes grass had followed several years of cotton and (c) eight years of repeated cotton following the breaking up of virgin grassland. Planted at the end of October following a 3-inch pre-planting watering, this set of trials developed satisfactorily until the 2nd of January, when a 3-inch watering was applied which was followed by a similar watering in the latter part of January. As it had been found last season that these soils, which have only a very slight slope, could not absorb more than a 2-inch spray irrigation applied at the rate of an inch per hour, small checks were constructed between the rows of cotton at roughly 6 ft. intervals to form basins to hold the water of a 3-inch application. The implement used to construct the checks consisted of a walking scuffler which had had the two rear shovels removed and a board with a curved edge to fit the contour between the rows attached instead. The method worked very satisfactorily and enabled an application of 3 inches of water to be held long enough for the water to soak into the ground.

Considered as a whole, the plants following the Rhodes grass area were of the most attractive type until after the February rains, when a dense foliage developed on all varieties in all three areas. A jassid attack which occurred at the end of February brought out the susceptibility of all the varieties except Umil 12, a partially resistant type developed by Mr. Marriott. No significant differences between varieties were obtained at the first picking in any of the areas. In the second picking Umil 12 and the next earliest fruiting variety were significantly ahead of all others except in the second year following Rhodes grass. In the third picking the jassid resistance of Umil 12 placed it well ahead of all other varieties in all three areas—a very important asset in irrigated cotton, where heavy top crops can be developed. It is significant, however, that the mean yield of the experiment after 3 years of Rhodes grass was approximately 502 lb. lint cotton per acre compared with 479 lb. after wheat and 475 lb. after 8 years of repeated cotton following virgin grassland, and that the total yield of Umil 12 was well below the average of the varieties in the first area whereas it was well ahead in the other two areas. These results appear to indicate once more the value of the grassland-cotton rotation and also that soil environment plays a part in the yields obtained under conditions of a moderate jassid attack.

SOIL MOISTURE AND NITRIFICATION STUDIES.

A comprehensive series of studies relating to soil moisture and nitrification was again carried out.

Determinations made at the start of spring indicated that the moisture content of the upper soils all over the station was well below permanent wilting point. Consequently the earlier rains did little more than provide sufficient moisture to enable the plantings to be effected. In an irrigation area 3 inches of pre-planting spray irrigation plus 1.51 inches of rain only moistened the soil to a depth of 13 inches although there were no signs of run-off either during the rain or the irrigation. In a fallowed area after 7 inches of rain had been received during the previous two months, the soils were wet to a depth of 15 inches only. There was no adequate reserve of subsoil moisture, therefore, to maintain the plants in good condition during later dry periods experienced at mid-season.

Owing to this lack of subsoil moisture, the 8.28 inches of rain spread over 7 days in mid-February wetted the soils to field capacity to an average depth of only 36 inches over the Station. The very rapid plant growth which followed this rain group drew severely on this moisture supply as was shown three weeks later when, following a rain group yielding 3 inches of rain, moisture determinations indicated that the soils had been wet to a depth of 37 to 38 inches only. By early in May this supply of moisture had been practically exhausted. The results, as a whole, confirm previous findings that unless a supply of subsoil moisture is available at planting time to around a depth of three feet, the obtaining of a highly satisfactory crop of rain-grown cotton under the conditions normally ruling at the experiment station is dependent on fairly regular rainfall being experienced during the main growing season.

Nitrate determinations, as a whole, confirmed previous findings—i.e., in seasons of no winter and very little spring rainfall the nitrate content of the 0-6 inch layer of old fertile cultivations rises rapidly after the occurrence of rains in October and November and readings may range above 30 p.p.m. by the end of December. Such quantities of nitrates stimulate the development of a very vegetative type of plant growth which reacts severely to hot, dry periods experienced later in the season.

COTTON VARIETIES.

The area planted to variety trials, strain tests, progeny rows and breeding plots this season totalled 17 acres, including trials and plots on district farms. Results were satisfactory in spite of the complete loss of one progeny plot and one increase plot through a *Loxostege affinitalis* invasion. All the trials included at least one of the jassid-resistant strains which are being developed, and in eight out of the nine experiments, jassid-resistant material gave highest yields, including four trials in which jassids were not a limiting factor.

The more important results of the season's work are summarized as follows:—

Cotton Breeding.—The main breeding work was confined to the production and further testing of jassid-resistant material by Mr. Marriott, but testing of the non-resistant Miller strain 43-9 was continued. Two bulk plantings of this strain of Miller yielded good increases of seed and it continued to show a high lint percentage (36.82 per cent.) as compared with the 34.5 per cent. of commercial Miller. Over 6,000 lb. of seed of this strain are now available. Progenies from this strain revealed apparent differences in fibre strength and there are further indications that the progenies with the strongest lint have lower ginning percentages than those with the weakest fibre. There is insufficient evidence to correlate this with suggestions made in last season's report but further trials of this material may indicate whether these fibre strength differences are constant.

Jassid-Resistant Miller.—Unfortunately the entire planting of jassid-resistant Miller progenies was wiped out by a *Loxostege affinalis* invasion as the seedlings were emerging from the soil. The very late replant failed to develop any crop, but reserve seed was kept for the coming season.

Two related jassid-resistant Miller strains from the family III-165 were increased in isolation. Yields were low through *Loxostege* damage and local drought, but one strain produced 1-inch and the other $1\frac{1}{16}$ -inch lint. Sufficient seed is now available for full-scale testing of yielding ability and if this is satisfactory these strains will represent a definite improvement over the fibre length of the present commercial jassid-resistant Miller Lot 1.

Jassid-Resistant Hybrids.—The hybrid progeny plot consisted entirely of Miller $\times$ U.4 or Miller $\times$ Rhodesian hybrids backcrossed to Miller. It appears that 6 years selection from second backcrosses has produced very good uniformity in plant and lint characters and in leaf hair density, while good uniformity also seems to exist in the fourth generation of a strain backcrossed to Miller four times. All these produce 1-inch cotton or better, and fibre strength and body of most are definitely above average.

Two hybrids which are sixth generation selections from (Miller $\times$ U.4) $\times$ Miller backcrosses were increased in a small isolated area and these will now be tested in large-scale variety trials. Past results from small trials indicate that their yielding ability is high.

Hybridisation work included the further backcrossing to the appropriate commercial parents of the hybrids of Lone Star, Mexico Acala and Triumph on the one hand, and Ferguson or a Rhodesian cotton on the other. Highly resistant and prolific Miller backcrosses which were handicapped by low ginning percentages were also crossed with the new Miller strain 43-9. This treatment has also been given to the very prolific hybrid variety Umil 12. Yields were high from the

plot—the mean being 1,590 lb. seed cotton per acre—and uniformity within the various hybrid strains is now becoming apparent, indicating that progress is being made in the isolation of definite plant types. Ferguson hybrids were more vegetative, later and lower yielding but were more hirsute. However, many of the Rhodesian crosses showed high resistance coupled with more open plant habit.

Strain Trials.—In addition to the main irrigated variety trial which has already been discussed, strain trials were carried out on various soil types and treatments and in each case a fixed hybrid gave highest yields both of seed cotton and lint. Under irrigation B.1-11-2-0-2-0-0 outyielded the main commercial Miller Lot 41.S and Miller 43-12-0 by more than 260 lb. seed cotton per acre, the differences being significant, while lint cotton yields in lb. per acre were B.1-11-2-0-2-0-0, 569 lb.; Miller 43-12, 507 lb.; and Lot 41.S, 488 lb.

Under rain-grown conditions in each of 3 trials of 13 strains, the hybrid B.1-2-2-0-4-0-0 gave highest yields, its mean yield per acre being 450 lb. seed cotton compared with only 230 lb. for Miller 41.S. The low figures for the standard commercial variety of Miller give an indication of the unfavourable growing conditions. Jassids were not a factor in these trials.

A yield trial of 3 varieties, Miller Lot 41.S, Miller Lot 41.J and Umil 12 covering about 9 acres was grown by a co-operator. Plot size was about 1 acre. Seed cotton yields in lb. per acre were: Umil 12, 588 lb.; Miller Lot 41.J, 368 lb.; Miller 41.S, 337 lb. There was only a slight jassid attack on this plot as evidenced by the close yields of 41.J and 41.S.

The late planted trial under irrigation which has been used in recent years to ensure a heavy jassid attack, again showed convincing evidence of the very high degree of resistance to jassid which has been obtained in many new strains. Yields were necessarily low owing to the shortened growing season incidental to the late planting.

The highest yielding strain, the backcross B.2-8-1-5-0-12-0 gave 517 lb. seed cotton per acre, while the control, Miller 42, was the lowest yielder producing only 182 lb. seed cotton per acre. Boll size was also much reduced in the Miller 42, and this was mainly due to the severe injury it suffered from the jassids. The following table summarises the results given by the new strains:—

Strain Trial.	No. of Strains.	Position of Commercial control Miller.	Highest yielding Strain.	Increased yield over control as % of control yield.
E.10	13	11	B.1-2-2-0-4-0-0	65.6
E.13	13	9	B.1-2-2-0-4-0-0	135.7
E.16	13	5	B.1-2-2-0-4-0-0	51.9
K.18	13	13	B.2-8-1-5-0-12-0	150.0
J.19-34	3	2	B.1-11-2-0-2-0-0	18.8
K.11-12	7	2	Rowden	9.6
K.13-14	7	7	Umil 12	56.2
K.15-16	7	2	Umil 12	4.7
Co-operator	3	3	Umil 12	74.5

Further studies on leaf hair characters again revealed that length of leaf hairs was always adversely affected by dry conditions, while density was also usually reduced, but not to the same extent.

ENTOMOLOGY.

Rainfall in the cotton growing districts has been below normal for some years. Improved weather conditions during 1946-47 were accompanied by some unusual features, chief among which was a wide-spread outbreak of the cotton web spinner *Loxostege affinitalis*. The early summer generation bred on weeds and invaded cotton crops in central and southern Queensland. The attacks occurred in November and losses were heavy where control measures were not promptly applied at the onset of the invasion. Established crops which survived the attack suffered little further damage by insect pests. Corn earworm, *Heliothis armigera*, was inactive for most of the season in central Queensland. One potentially dangerous peak of activity occurred in early January but few of the larvæ survived. In southern Queensland, however, outbreaks were severe during the summer and some spectacular attacks took place. The cotton jassid *Empoasca maculata* attracted little interest except in areas where good rains occurred late in the season. In some cases a potentially payable top crop was destroyed.

Terminal injury was relatively high in cotton grown on the Regional Experiment Station at Biloela. Two insects, the cotton web spinner and the corn earworm, were involved, the former being the more important. Plant structure throughout the experimental areas was therefore not particularly good.

Of the three entomological experiments, two gave no worthwhile information owing to the absence of insect attacks of economic importance. Both were located on non-irrigated cotton crops which gave tolerably good yields. The other experiment was an insecticidal trial on irrigated cotton and designed primarily to assess the merits of D.D.T. as an insecticide for the control of *Heliothis*. D.D.T. sprays containing 0.3% of the active constituent were compared with a 4% D.D.T. dust and a 90% lead arsenate dust. The D.D.T. treatments were applied once and the lead arsenate treatment twice at each potentially dangerous peak of *Heliothis* activity. Increased yields up to 330 lb. of seed cotton per acre were obtained in the first pick from this experiment. An 0.3% D.D.T. spray proved the most efficient of the several treatments. Only one major peak of *Heliothis* activity occurred when the crop was fruiting. Attempts to assess the effect of the treatments in terms of the squares injured by the larvæ were unsuccessful and there is some doubt as to whether or no the increased yields can be wholly attributed to effective control of *Heliothis*, for other pests such as Mirid bugs were numerous on the crop.

EXPERIMENTAL PROGRAMME FOR THE SEASON 1947-48.

The proposed programme for 1947-48 embraces the following investigations.

Plant Breeding.—

- (a) A continuation of the testing of the merits of the various generations of backcrosses of Miller and U.4.
- (b) A continuation of the testing of the merits of the various strains selected from Miller for jassid resistance and the multiplication of Lot 1.
- (c) A continuation of the backcrossing programme with the Mexico Acala, Lone Star and Triumph hybrids.
- (d) A continuation of the testing of the Miller strain 43-9, with special reference to the progenies from this strain.
- (e) Increasing the seed stocks of Miller 42 and the bulk selection from Mexico Acala 120.
- (f) Commencement of exploratory work on the suspected variations in drought resistance and shedding of several new strains and hybrids.

Agronomic and Varietal Experiments.—A continuation of the general programme attempted in the 1946-47 season and amplifications of the same in certain directions.

New work will include :—

- (a) An investigation of methods of cultivation of cotton.
- (b) Testing the merits of “ basin listing ” to obtain better retention and penetration of rainfall during the growing season.
- (c) Mechanical harvesting of cotton.

Entomology.—

- (a) Insecticide experiment on irrigated cotton to test further the efficiency of D.D.T. as an insecticide for the control of *Heliothis*, with particular reference to times of application.
 - (b) Insecticide experiment on rain-grown cotton to compare with D.D.T. two treatment schedules which are tentatively recommended to cotton growers at the present time.
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SOUTH AFRICA.

COTTON EXPERIMENT STATION, BARBERTON. PROGRESS REPORT FOR THE SEASON 1946-47.

INTRODUCTORY NOTE

BY

D. MacDONALD.

STAFF.

At the end of October, 1946, Mr. F. R. Parnell left this Station to take up duty as Director of the Cotton Research Station, which is being established at Namulonge in Uganda. Mr. W. L. Fielding resigned from the staff in order to take up an appointment on the Sugar Experiment Station, Mount Edgecombe, Natal. Dr. R. C. Rainey has been absent from the Station since December, 1946, first on overseas leave and then on temporary secondment to the Anti-Locust Research Team working in Somaliland. Mr. J. M. Munro reported for duty as Assistant Plant Breeder in October, 1947.

INTRODUCTION.

Climatic conditions in the Barberton Valley and the Low Veld generally vary greatly from season to season, and since work on this Station began no two seasons have been alike. From the breeder's point of view, most of them have been difficult, though the nature of the difficulty has varied from prolonged droughts to flood, hail and excessive pest damage. It is, therefore, all the more pleasing to report that season 1946-47 was one of the best experienced during the past twenty years. Apart from a heavy attack of American bollworm in February, followed by a moderate drought in March, conditions were generally good and high yields per acre were obtained, thus enabling seed reserves of valuable strains, which had been reduced to dangerously low levels by hail damage in season 1945-46, to be built up.

The attack of American bollworm, followed by drought, was useful as it enabled records to be obtained on the powers of recovery from both bollworm and drought exhibited by the latest hybrid selections, powers which in many cases were very satisfactory.

A tabular summary of the season's conditions is given in Table I.

TABLE I.

<i>Planting Dates.</i>	<i>Picking Dates.</i>	<i>Legal Close Season.</i>	<i>Rainfall.</i>	<i>Mean Temperatures.</i>
7th-14th November	May to August	Nil	Total for 12 months ending 30th June, 27.94 inches	1/11/46-30/4/47 Max. 82.9°F. Min. 63.4°F

The basic breeding programme followed that of previous seasons dealing mainly with variety tests of, and selection within, hybrid material derived from inter- and intra- species crosses. Investigations into the effect of climate, locality and soil conditions on hairiness were continued. Routine hair counts on leaf lamina strips from a number of our most promising selections were carried out to ensure that the required standard of hairiness was kept up. Shortage of staff limited the amount of this work that could be done in the time available, but a new technique, details of which are given on page 20, has been evolved, by which increased numbers of leaf lamina strips can be examined in a much shorter time.

Insect damage, apart from that already mentioned, was confined to a light aphid attack in January and, although stainers were numerous from March onwards, the incidence of internal boll disease was very low. Routine counts of nymphs, on a range of susceptible types, gave evidence which showed that a normal jassid population was bred up during the season.

Despite the improvement in cotton lint prices, the acreage under cotton in the Barberton district was only double that of the previous season, due largely to the fact that little effective rain fell in the area between March and early November, 1946, thus limiting the amount of dry land that could be prepared for planting. The gross production of seed cotton was approximately three times that of the previous season, the total crop being sold locally at $1/3\frac{1}{2}$ d. per lb. lint and £15 per ton for seed, both prices being f.o.r. Barberton.

At the above prices cotton is a very remunerative crop and this, allied to the two following facts, (1) the continued drop in prices received by the producer for vegetables, and (2) the establishment of textile industries in the Union of South Africa, which are capable of absorbing all the cotton S. Africa can produce for many years, has given a great impetus to future cotton production.

Futhermore, when cotton lint is sold to local manufacturers, the grower receives payment for his product much more quickly than when it is sold on the export market, a very important consideration to new growers who are starting farming without large capital reserves.

So far sufficient seed to plant 6,000 acres in the coming season has been sold to growers in the Barberton District, while from other areas like Zululand, Swaziland and the Northern Transvaal, which had ceased to produce cotton for many years, renewed applications for seed have come in.

With present prices, the chief factors which will limit increased production are seasonal conditions, plus the shortage of tractors and other farming machinery necessary for cultivating large areas of land. In addition shortage of labour to pick a greatly increased crop might

make itself felt, but this may be overcome eventually by mechanical pickers.

METEOROLOGY.

The rainfall for the season, totalling 27.94 inches, was ample for the crop and apart from a very dry spell in March was reasonably well distributed. Following good rains in early November all cotton planting was finished by mid-November, the resulting stands being excellent. Growth during the first three months of the season was very good, and it was not until the period between February 25th and March 29th, when no effective rain fell, that signs of moisture shortage were evident in the crop. Following well distributed rains from the 29th March until the end of April, a good recovery was made and all the late set crop matured and opened well.

PLANT BREEDING SECTION.

BY

D. MacDONALD and H. E. KING.

GENETICS AND BREEDING.

Main Variety Trial.—In the season 1945-46 a balanced incomplete block trial of 25 strains, planted in order to compare the yields of the best U.4/5143 × Cambodia strains with the best U.4/8161 × M.U.8 strains, was so badly damaged by hail that comparable yield figures were unobtainable, though lint samples were obtained which gave a comparison of the relative spinning values of the strains from the two crosses.

The trial was accordingly replanted during the present season to compare the yields of the 13 best 5143 × Cambodia strains with the 10 best 8161 × M.U.8 strains along with two standard U.4 strains, including 5143.

Initial and final stands (a mean of 87% for all strains in the 12 blocks of the trial) were good, but early growth during the first two and a half months after germination was slow compared with that of cotton on other fields planted about the same date. A possible reason for the slow development in the early part of the season may be the fact that a broadcast crop of sunnhemp had been ploughed in rather late in the previous season, and as no winter rains fell it only began to decompose when the spring rains came.

Due to the slow early rate of development no strain in the trial had fruited heavily when a severe attack of American bollworm in early February destroyed all the buds, flowers and bolls produced. Coinciding with the end of the bollworm attack in late February vigorous growth and heavy fruiting began throughout the trial and

good rains from the end of March onwards enabled a very heavy crop to be matured.

Final yield figures were very high, the mean for all strains in the trial being 497 lb. lint per acre. The highest yield was that of the 5143 × Cambodia selection A.2106, with 622 lb. lint per acre, closely followed by the 8161 × M.U.8 strain A.449 with 599 lb. lint. In comparison 5143 yielded 426 lb. lint, the difference required for significance being 39.0 lb. lint per acre. Furthermore this yield of 622 lb. lint given by A.2106 was significantly higher than that of any other strain in the trial except A.449.

In all variety tests which have included A.2106 since 1943-44, this strain has always given the highest yield, significantly outyielding U.4/5143, the strain at present in general cultivation, the mean increase over 5143 for all trials being 46%. This fact is all the more noteworthy as climatic conditions during this period have differed widely, no two seasons being alike.

Comparing the relative yields of the two main groups, 5143 × Cambodia and 8161 × M.U.8 in the trial, the mean yield in lb. lint per acre, for the latter group of 10 strains, was 527 against 484 for the 13 Cambodia crosses. All 10 of the M.U.8 crosses significantly outyielded 5143 but while all the 13 Cambodia crosses gave higher yields than 5143, the increased yield given by four of the strains failed to be significant.

Commenting on the samples of the above strains sent to Didsbury for spinning tests the previous season the Shirley Institute reports: "The U.4/8161 × M.U.8 hybrids were consistently good in strength and some (particularly A.449 and A.455) were also good in appearance. The U.4/5143 × Cambodia hybrids were on the whole weaker and poorer in yarn appearance. The yarns from 5143, though fairly good in appearance, were the weakest."

Variety Trial II.—Nine strains consisting of 5143, A.2106 and an 8161 × M.U.8 strain, together with five selections from 8161 × Sea Island families, were planted in a randomized block trial in an attempt to get reliable figures to compare the yields of the Sea Island hybrids with those of our standard *hirsutum* strains.

The fine linted Uganda B.P.52 was also included, as it was intended to take lint samples from this trial in order to find out how the hair characters and spinning qualities of the Sea Island hybrids compared with B.P.52 and the standard *hirsutum* strains.

Early growth and fruiting were generally very good but aphid attack in January, followed by American bollworm in February, completely destroyed the crop which the strains had already produced. Recovery during March was fair but April rains coinciding with a rapid spread of *Alternaria* on this particular field rendered final yield figures useless. From field observations, before bollworm appeared, the general standard of fruiting of the Sea Island strains was at least as good as that of all the *hirsutum* strains with the exception of A.2106.

Seed Multiplication.—The 150 lb. of seed of strain A.2106 issued to a few selected farmers in 1945-46 resulted in just over 6 tons of seed being available for distribution at the beginning of the present season. This amount was redistributed over a wide area to a much greater number of farmers with the result that, at the end of the season, sufficient seed was available to supply the requirements not only of the growers in the Barberton area, but also of those growers in Swaziland, Zululand and other parts of the Union for the coming season. Reports on the cropping capacity of A.2106 have been good wherever it has been grown in this district, and personal observations have borne out these reports, but only when all growers can be made to realize that a strong growing, vigorous strain like A.2106 requires a wider spacing than strain U.4/5143 which it is replacing, will the full benefit of its cropping capabilities be obtained.

HYBRIDIZATION.

U.4/5143 × Cambodia.—The work on these crosses was largely confined to field examination of the lint of individual plants, in order to see if plants with longer and finer lint than the general average could be found. Examination showed that wherever this was possible it was normally associated with the lowering of other desirable characters such as ginning %, fruiting and hairiness, and that to effect even a small improvement in lint quality, without loss of other economic characters, would require much more time than is available. Accordingly this line of work will be discontinued.

U.4/8161 × M.U.8.—American bollworm attack in this group of crosses was so severe and prolonged that it was impossible to make single plant selections. The material is accordingly being carried forward in the form of special bulks.

Quality Crosses.—Examination of the progenies derived from crosses between our best U.4 strains and M.U.8 with *G. hirsutum* and *G. barbadense* types of high lint quality constituted the major part of the breeding programme. The aims and objects of this work have already been given in previous Reports and need not be repeated.

When work was begun on improving, by hybridization, the lint quality of our best U.4 strains (without a corresponding loss of the desirable economic characters like heavy fruiting and jassid resistance which they already possessed), little information was available to guide us in the choice of which high quality lint parents we should use.

Previous experience of crosses within *G. hirsutum* had shown that it was impossible to predict in advance how the resulting progenies would behave. This was well illustrated when Cambodia was crossed with two sister U.4 strains, 5143 and 5149, the Cambodia × 5143 giving rise to many excellent families including A.2106, while in the Cambodia × 5149 families nothing really good could be found.

In view of this, when work on improvement of lint quality was begun, as large a number as possible of parents known to possess high quality lint, were used to cross with the best U.4 strains and M.U.8. It is of interest, now that this work has been in progress for some years, to summarise the results obtained.

Coker Wilds when crossed with U.4 and M.U.8 yielded no progenies of any value. All plants possessing lint approaching that of *Coker* showed poor fruiting and jassid resistance, while all plants combining good fruiting with good hairs showed no improvement in lint quality over the U.4 and M.U.8 parents.

Tidewater crossed with U.4 showed complete susceptibility to jassid except for a few plants with poor lint. On the other hand *Tidewater* $\times$ M.U.8 showed improved resistance to jassid and better fruiting but generally poor lint. In a large F_2 population, however, 5 plants were found which exhibited the desired combination of lint, fruiting and hairs and from the progenies of these plants very promising material is being carried on.

Meade crossed with U.4, M.U.8 and Uganda B.P.52 gave some fair material but all this group were discarded during this season, not because they were really bad, but because an ample supply of much more promising progenies derived from other crosses is available.

The progenies of Gen 33 when crossed with either U.4/5143 or M.U.8 have also been discarded as they offered little promise.

Of the inter-species crosses made, *B.P.52* $\times$ *Tanguis* has produced nothing of any value.

The crosses whose progenies offer most promise of yielding stable strains, combining field characters equal to that of our best U.4 strains with improved lint, are as follows :

- (a) *Intra-species Crosses.* M.U.8 $\times$ *Tidewater*, 5143 $\times$ B.P.52, M.U.8 $\times$ B.P.52.
- (b) *Inter-species Crosses.* U.4/8161 $\times$ Sea Island and Egyptian and to a lesser extent M.U.8 and B.P.52 $\times$ Sea Island.

M.U.8 $\times$ *Tidewater*.—It was mentioned in last season's Report that, on account of hail damage, only a little reserve seed of single plant selections from this cross was available for replanting. In some cases the amount of seed available was so small that seed from two plants showing similar field and lint characters was mixed, in order to give a progeny plot of reasonable size at a very low seed rate. In all, 47 single plants and 5 special bulks were grown and, despite the low seed rate, very good stands were obtained.

Uniformity both within and between progenies was good ; the type of plant produced by this cross being strong, vigorous and free fruiting, somewhat similar to A.2106 in habit. The boll size is generally larger than the big balled *Tidewater* parent, while leaf hairiness in many plants equals, and sometimes exceeds, the hairy

parent M.U.8. Lint lengths vary between progenies but those of single plant selections from the best progenies lie between 35 and 38 mm.

Ginning % though variable is generally low, about 31 to 32 %, the seed weight being regularly high.

As strains from this cross have not yet been included in standard variety trials, accurate yield figures are not available, but yields from progeny plots of approximately one-thirtieth acre ranged from 400 to 500 lb. lint per acre.

5143 $\times$ B.P.52 and M.U.8 $\times$ B.P.52.—Field and laboratory examination of selections from the first group showed that a small proportion of plants could be found combining the good qualities of both parents, but in the M.U.8 $\times$ B.P.52 progenies practically no single plants could be found which combined the hairs and good fruiting of M.U.8 with lint approaching the B.P.52 standard.

Progenies derived from these crosses backcrossed to B.P.52 in the F_1 generation were regularly better, particularly so in the M.U.8 group. Within this group it was easy to find prolific fruiting plants, with hairs approaching the standard of M.U.8, combined with lint equal to B.P.52 in length, and fineness, as judged by feel. In many cases, these characters were combined with a ginning outturn higher than that of either parent. From this single backcross 60 single plant selections are being carried forward, whose ginning outturn lies between 34 and 36 %, combined with lint lengths ranging from 34 to 37 mm.

Sea Island and Egyptian $\times$ B.P.52.—Selections from these crosses now in the F_4 generation were grown in a two-acre block. As in earlier generations, progenies of the Sea Island cross showed up better than those of the Egyptian in all characters. This block of cotton escaped bollworm damage in February, but in spite of this the general standard of fruiting was low compared with other groups of hybrid material. Uniformity, both within and between progenies, was poor, even when allowance is made for the material being only in the F_4 generation. Both lint lengths and ginning percentages were generally low, while long linted plants were normally poor fruiters and jassid susceptible.

A small number of plants exhibiting the required combination of characters were selected, mainly in the Sea Island group, and these are being carried forward. Work on this material will be curtailed in future in order that the time saved can be devoted more profitably to more promising material.

It was mentioned in last season's Report that a small number of selected plants from this cross, which, while possessing good lamina hairs, had naked stems, were being planted to see whether their progenies split for habit, fruiting and hairs, in the same way as progenies derived from similar plants in the U.4 $\times$ Sea Island group.

In spite of the low standard of uniformity within progenies already referred to, it was very noticeable that the lowest degree of

uniformity covering habit, hairs, fruiting and lint characters was found in progenies derived from these plants.

M.U.8 × *Sea Island*.—The opinion formed during the previous season that this cross, while having a higher limit of hairiness than the *U.4* × *Sea Island* cross, was inferior to it in habit, fruiting and lint length, was confirmed during the present season. The proportion of plants of this cross, now in the F_5 generation, which could be found to give the combination of good lint, fruiting and hairs was much lower than the proportion that could be found in the *U.4* × *Sea Island* group in the same generation. Opening in many progenies was rather sticky and this character did not appear to be confined to any particular type of plant. So far as can be seen, the main value of this cross lies in the number of plants it gives with what may be called super hairs judged on length and density. Selection, with a view to obtaining the best hairs possible, will be carried on until accurate information is available, as to what resistance, if any, very long and dense hairs will give a plant against *Lygus* attack.

U.4/8161 × *Sea Island and Egyptian*.—A total of 686 economic single plant selections and 83 special bulks from these two crosses were planted in an 18 acre block. About 80% of these selections are in the F_7 generation, the remaining 20% being F_6 's grown from reserve seed of selections destroyed by hail in the previous season. Well over 80% of these selections are derived from the *Sea Island* cross.

Stands and growth were regularly good over the whole area occupied by these crosses and any differences that showed up, either within or between families, could be confidently taken to be due to inherent strain differences. Approximately 90% of the progenies which are now being carried on in the *Sea Island* cross are derived from two single plant selections, A.3313 and A.3355, made in F_3 , derivatives of A.3313 constituting the major portion. These two families, though both showing great promise, differ markedly in many characters. A.3313 progenies give rise to strong, but not coarse, vigorous, rather open, prolific fruiting types, which are in many cases earlier than the *U.4* parent. The boll is regularly larger than that of *U.4*, while opening is markedly good. The standard of hairs is well above that of *U.4*, and lint lengths seldom fall below 36 mm. Its main disadvantage is that the ginning percentage is rather low but this is compensated by prolific fruiting.

The progenies of A.3355 are rather less vigorous in habit of growth being generally rather bushy, compact types, and more leafy than the A.3313 group. Fruiting though good is not quite as early as A.3313 strains, the boll being smaller and opening generally good. Lint lengths are slightly lower but ginning percentages are good, and plants with the pleasing combination of 34% ginning outturn and 35 mm. lint are readily found. The standard of hairiness is well above that of *U.4*.

Uniformity both within and between progenies was good in both families but was better in the A.3313 family.

When American bollworm attack began in early February these two families had already fruited very heavily, but the attack was so severe that nearly all except the very early set bolls were destroyed. It is very satisfactory to record that when the attack ceased, recovery was excellent, and despite the March drought, a very large top crop was set and matured. Judged on progeny plot yield figures, the best lots gave as high as and in some cases higher yields than our standard U.4 strains, but accurate comparisons of yields will have to await the results of variety tests which it is proposed to carry out next season.

In progenies derived from families other than the above two the general standard was not so consistently high. While fruiting and hairs were reasonably good, some lines showed distinctly poor opening in a season when opening was generally good. This character of sticky opening was commonly though not always associated with "bunch" or "cluster" habit of fruiting.

In all nearly 600 economic single plant selections, together with numerous special bulks are being carried forward.

Spinning Tests.—It was hoped to be able to send lint samples, taken from a variety trial, of some of our best hybrid strains for spinning test to see how they compared in spinning quality with B.P.52. Unfortunately, owing to bollworm attack followed by *Alternaria*, this was not possible. Many of our hybrid families have now reached the stage at which it is essential to find out as soon as possible, in order to assist in future selection work, what differences in spinning quality exist, both within and between different groups of crosses. Accordingly lint samples taken from progeny plots of 19 of our most promising hybrid strains have been forwarded to the Shirley Institute, along with samples of lint from B.P.52 to see how they compare, both in hair characters and spinning quality.

PLANT HAIRINESS AND JASSID-RESISTANCE.

No experiments were laid down this season on the relationship between hairiness and resistance to jassid but routine counts of nymphs were made on a number of standard strains. These counts indicated that jassid incidence was at normal levels, viz., heavy on non-hairy types and extremely low on hairy strains.

The investigations of the previous four seasons are considered to have established beyond doubt that the observed relationship between leaf hairiness and infestation is one of cause and effect, and that measurements of lamina hairiness are an unfailing guide to potential jassid resistance*. A review of the results of all experiments and observations has led to the conclusion that *under Barberton conditions*, a degree of hairiness of lower surface lamina giving counts of over 60

* A paper summarizing these investigations has now been completed and accepted for publication in the Bulletin of Entomological Research.

hairs per sq. cm. at a height of .5 mm. will confer satisfactory resistance. Counts of 150 or more hairs at this height indicate a level of hairiness which will confer virtual immunity.

Effect of Conditions of Growth on Hairiness.—Some further observations were made this season on the variation in hairiness associated with locality, climatic and cultural differences, including some further investigation in co-operation with Mr. J. E. Peat, of the behaviour of A.2106 grown in Tanganyika. With much better rains this season, the hair figures for Tanganyika growth were much better than those of the previous, very droughty, season. This confirms previous observations at Barberton that rainfall is of predominant importance. At the same time it seems clear that soil fertility, and perhaps local climatic differences other than rainfall may have a definite effect. In comparison with typical good growth at Barberton, it appears that A.2106 grown at Ukiriguru (Tanganyika) does not maintain so high a level of hairiness through the season, even with adequate rainfall. A note summarizing the results of all available observations on this problem is in course of preparation.

The main practical conclusion is that a high potential level of hairiness is desirable in order that the level attained even under poor growing conditions will be adequate. A.2106 may be considered satisfactory in this respect except when faced by a combination of very low soil fertility and extreme drought in an area with high jassid population.

Selection for Improved Hairiness.—Past results of breeding work have shown that strains of greater hairiness, and hence greater jassid resistance, can be selected solely by eye-judgment of degree of hairiness in the field. These results, however, were obtained with material in which the range of hairiness was so marked as to be at once apparent to the eye. In addition there was, in general, a positive correlation between density and length of hairs, and the highest densities occurring were not of a high order.

With the hybrid material now available the judgment of degree of hairiness is much less easy. Very much higher densities are met with than in *G. hirsutum* selections, and the variation in length of hairs is masked, to the eye, by variations in density. The highest densities are not associated with the highest numbers of long hairs, there being a definite tendency for a *negative* correlation between density and length in *G. hirsutum* $\times$ *G. barbadense* material.

Under these circumstances it is, therefore, very desirable to make use of actual counts of hairs of the desired length. The photographic technique described in the 1943-44 report, yielding counts of hairs exceeding a specified vertical height, gives figures of adequate accuracy in this respect but is slow and expensive as a routine for use in breeding work.

A simplified technique has now been worked out which provides the same figures, to a similar standard of accuracy, while omitting the

The disease is not common in the Barberton District generally which is typically granite soil, and most of the attacks have been confined to the loam soil of the Station. Young, vigorously growing plants are not materially affected and symptoms of the disease only occur when the early bolls are nearing maturity. The spread of the disease is in many cases very rapid and within three weeks of the onset of the disease the crop may be completely defoliated.

Early heavy fruiting plants are first attacked, while plants stripped of their bolls remain unaffected, i.e., a high boll/leaf ratio favours the rapid development of the disease. On the other hand any reduction of boll/leaf ratio, whether due to strain, vigorous growth, manuring or soil differences may delay or even prevent the attack. The edge rows of a plot normally remain green long after the inside of the plot is defoliated and in some cases mature their total crop without showing any symptoms of the disease.

Various manurial treatments including a range of minor elements have been tried to see what effect they had on the disease. Details of the results obtained have been given in previous reports, and it need only be stated here that both compost and potash dressings markedly postponed but did not prevent the occurrence of *Alternaria*.

During previous seasons 12 leaf samples relating to *Alternaria* were taken and a chemical analysis made of them at Rothamsted. We wish to record our sincere thanks to Dr. E. M. Crowther, Dr. W. E. Chambers and Mr. H. G. Warren of Rothamsted for arranging and carrying out this analysis. A description of the samples is given below.

12 samples each consisting of one leaf from 100 or more plants, dried and ground.

The leaf taken was the first fully grown leaf of normal colour from the top of the main stem. Petioles were removed.

The samples were taken shortly after *Alternaria* made its appearance. In all cases the crop was approximately 4 months old.

The duplicates in the fertilizer experiment are two samples taken separately.

From Experiment on Premature Leaf-Fall, Progress Reports,
1941-42, p. 38. Strain 5143.

K (1) and (2) = 500 lb. p.a. K_2SO_4 —500 lb. p.a. superphosphate.

C (1) and (2) = 12 tons p.a. Compost—500 lb. p.a. superphosphate.

KC (1) and (2) = K_2SO_4 —Compost as above—500 lb. p.a. superphosphate.

In each of the above treatments *Alternaria* was delayed by about 3 weeks, but then developed a severe attack. Unfortunately the treatments not receiving Potash or Compost suddenly started to go off

with *Alternaria* very early and unexpectedly and we were unable to take samples from them. The two samples under "Edge Effect" below, 5143 Inside and 920 Inside, will act as controls to the above, however.

Differences due to Edge Effect.

5143 *Edge*.—From outside edges of a plot; plants bordering a vacant space.

5143 *Inside*.—From the centre of the same plot.

920 *Edge*. } Similar to above.
920 *Inside*. }

In the case of each strain, the "inside" plants showed an early and heavy attack of *Alternaria*, just before the early bolls started to open. The "edge" plants remained green and healthy for some weeks longer and showed very little *Alternaria* as they closed down.

From Neighbouring Farms.

Spear.—A well grown crop of 5143, giving a heavy yield, on granite soil following heavily manured tobacco. Sampled when earliest bolls were opening, but leaf perfectly green and healthy. No *Alternaria* appeared later.

Evans.—Similar in all ways to the above, but carrying slightly less crop. Soil slightly poorer and less heavily manured in the past.

TABLE III.

No.	Amount of <i>Alternaria</i> .	% of Dry Matter.						Parts per million Mn.
		N	P ₂ O ₅	K ₂ O	Na ₂ O	MgO	CaO	
8	VERY SEVERE.							
10	5143 centre	2.99	0.75	0.28	0.26	1.42	3.70	43
	920 centre	2.85	0.89	0.35	0.25	1.55	3.39	37
	SEVERE.							
1	K 1 } duplicates	2.99	1.10	0.42	0.26	1.50	3.75	66
2	K 2 } duplicates	2.86	1.07	0.43	0.24	1.69	3.12	61
3	C 1 } duplicates	3.19	1.20	0.48	0.23	1.77	4.06	60
4	C 2 } duplicates	3.02	1.33	0.49	0.23	1.46	3.08	45
5	KC 1 } duplicates	3.08	1.25	0.46	0.28	1.76	3.81	59
6	KC 2 } duplicates	2.83	1.13	0.51	0.20	1.21	3.17	57
	SLIGHT.							
7	5143 edge	3.68	1.12	0.90	0.14	0.94	2.60	38
9	920 edge	3.19	1.05	0.86	0.07	0.69	2.73	41
	NIL.							
11	Spear	3.59	1.37	1.80	0.06	0.55	3.87	28
12	Evans	4.29	1.38	0.78	0.33	1.32	3.44	35
	AVERAGES.							
	Very severe	2.93	0.82	0.31	0.26	1.48	3.54	40
	Severe	3.00	1.18	0.46	0.24	1.56	3.50	58
	Slight	3.44	1.08	0.88	0.10	0.82	2.66	40
	Nil	3.94	1.38	1.29	0.20	0.94	3.66	32

The figures given in the above table show very clearly that potash deficiency predisposes the cotton plant to *Alternaria* attack, and field observations during the present season have given added confirmation.

Since the outbreak of war the shortage of inorganic fertilizers in general and potash in particular has limited the amount of potash obtainable, but last season it was particularly noticeable that cotton grown on fields which had received a dressing of 3 to 4 tons of compost every alternate season, and had in addition received two or more dressings of 160 lb. per acre of potash, was markedly free from *Alternaria*, compared with cotton grown on lands which had not received a potash dressing. The main block of land under our single plant selections receiving compost and potash regularly showed no *Alternaria*, whereas on certain fields, like the one under Variety Trial II already mentioned, which had received little compost and less potash in previous seasons, as well as on fields under Wilt Experiments, which had received neither compost nor potash, *Alternaria* caused a definite reduction in final yields.

WILD COTTONS.

A small quantity of seed of *G. armourianum* and *G. anomalum* × *G. arboreum* received from Mr. J. B. Hutchinson was planted. *G. armourianum*, which exhibits resistance to bollworm in the Sudan, failed to develop under our conditions, and as only one plant, which has made no attempt to produce any fruit, now survives, no information regarding its resistance to bollworm could be obtained. *G. anomalum* × *G. arboreum* is reported to develop hair earlier in the seedling stage than New World cottons. This polyploid produced large vigorous plants, which exhibited a range of hairiness from very sparse to moderately good hairs. In no type was there any sign of hairiness developing earlier than our standard *hirsutum* strains. Counts of hairs on leaves of the 6th, 8th and 10th nodes from some of the hairiest plants showed that values both for total hairs and hairs exceeding a height of .5 mm. were well below those of typical M.U.8. The rate of increase in hairiness from node 6 to node 10 was roughly similar to that normally found for *G. hirsutum* types, such as 5143 and M.U.8. This cross produced an abundance of squares but shed all it produced, the majority of the buds being shed before the flowering stage was reached.

Gossypioides kirkii had been grown in past seasons and though examined periodically no Red bollworm eggs or larvæ were ever found on the plants. Last December, following the cutting back of some ratoon cotton, adjacent to *G. kirkii*, which was being attacked by Red bollworm, a heavy Red bollworm egg laying was recorded on *G. kirkii*. To make identification certain, 2nd instar larvæ were collected from the *G. kirkii* plants and bred through to the moth stage in the laboratory. The larvæ were fed entirely on buds and young bolls of *G. kirkii*, the resulting moths being identical in every respect with Red bollworm moths apart from being slightly below normal size. It is evident that while *G. kirkii* may not normally act as a host plant for Red bollworm, in the absence of other cotton plants the moth will lay on it and the resulting larvæ can feed and develop normally.

ROTATION CROPS.

A normal range of rotation crops was grown and while early planted maize yields were very good, the March drought reduced the yields per acre of bean crops very considerably, markedly so in the case of soya beans. Groundnuts promised well, but the April rains delayed harvesting and a certain amount of the earliest produced nuts were lost on account of germination in the shell.

Streak.—The incidence of streak disease was very high in any late planted susceptible strain of maize ; the percentage infection in a maize variety trial planted in late December and recorded nine weeks later is given in Table IV.

TABLE IV.
% INFECTION.

Strain.	Light.	Medium.	Heavy.	Total.
Hickory	22.4	32.7	32.1	87.2
Peru	10.8	2.4	0.3	13.5
Peru x Hickory	5.8	1.1	0.4	7.3

Reports received during the past season indicate that streak is spreading to areas where it was not commonly found in the past, as well as to higher altitudes. Requests for seed of streak-resistant maize have come in from widespread districts and though the demand greatly exceeded the available supply, four and a half tons of resistant seed were selected and distributed at the end of the present season.

PROGRAMME OF WORK FOR 1947-48

COTTON BREEDING.

Variety Tests.—Twenty nine of the most promising strains derived from U.4/8161 x Sea Island, U.4/8161 x Egyptian, M.U.8 x Tide-water and M.U.8 x BP.52 will be included in variety tests along with our best *hirsutum* strains, in order to get an accurate comparison of their yields. Uganda BP.52 will be included in these trials in order to see how lint samples from the above hybrids compare with those of BP.52 and with our standard *hirsutum* strains in spinning tests.

Genetics and Breeding.—Work will be continued on the hybrid material described in the present report. Over 1,000 single plant selections and a large number of special bulks are being carried forward.

Hairiness and Jassid Resistance.—Work will be confined to the examination of a large number of leaf lamina strips, by the technique described in the present report, in order to get an accurate comparison of the relative length and density of hairs on our most promising

hybrid selections. Analysis of data dealing with the effect on hair development of climatic conditions, soil fertility, locality, etc., will be completed and the results written up.

Fibre Hair Weight and Maturity.—Investigations with a view to evolving a rapid but accurate technique for measuring hair weight and maturity of lint from combed seeds of different strains will be carried out as time permits.

Wild Cottons.—Seed of a range of wild cottons has been supplied by Mr. J. B. Hutchinson, and these will be grown to see how they behave under local conditions and to observe what resistance, if any, they show to bollworm and other insect pests in this area.

PLANT PATHOLOGY SECTION.

BY

G. M. WICKENS.

Generally good conditions enabled much of the extensive programme of work on *Verticillium* wilt disease (*V. dahliae*), bacterial blight* (*Xanthomonas malvacearum*), and internal boll disease (*Nematospora gossypii*) to be carried out, with main emphasis on the first-named.

The incidence of other pests and diseases, of which bollworm, aphids, termites and *Alternaria* following senescence were at some stages notable, was generally light and judged not to invalidate any of the deductions drawn.

Over the Station generally, the incidence of wilt and bacterial blight is recorded under their respective sections; internal boll disease was slight in spite of the fairly early immigration of stainers (*Dysdercus nigrofasciatus*) in what appeared to be fair number.

The occurrence of wilt disease has for the first time been observed and confirmed on two farms in the district. It is not possible as yet with confidence to forecast future development.

Future work on bacterial blight at Barberton will be greatly helped as the result of my visiting, upon my return from overseas leave, the Shambat Station in the Sudan. There I was able to see both the technique and the results of Dr. Knight's spraying inoculation method, and in the light of this to discuss with him and with Mr. J. B. Hutchinson, problems arising from the failure of the first season's application of the method here.

* This is used as the collective term to include the three terms "angular leaf spot", "blackarm", and "bacterial boll disease", each of these being aptly descriptive of its particular manifestation. The pathogen responsible is the same as that previously described as *Bacterium malvacearum*.

VERTICILLIUM WILT DISEASE.

Variety Trial.—This experiment was designed to evaluate the relative reaction of 6 varieties, U.4/5143, A.2106, M.U.8A, BP.50/3, BP.52 and B.181, to natural infection. It comprised 52 randomised blocks, each of 13 rows of 37 hills at 3 feet $\times$ 2 feet spacing made up of 1 row of each of the 6 varieties, each having on either side a row of U.4/5143 as a susceptible control. The experiment covered about 3.3 acres, in which the disease had been observed in the previous cotton crop.

From the time of first appearance of the disease, shortly before flowering, the position of every diseased plant was mapped at intervals ; weekly at first and later at longer intervals. Stands and yields of seed cotton were recorded separately for every row.

The occurrence of disease was sporadic and varied greatly in intensity over the experimental area, ranging in blocks at the final recording from about 1% to about 90%.

The disease developed in a manner similar to that previously recorded, namely at an increasing rate at first, and later decreasing. Developmental rates, in successive intervals of time, were similar relatively to each other in the several varieties, and also in areas of widely varying degrees of infection. There was one exception, namely a greater falling off in U.4/5143 in the last recorded interval than in other varieties to which it had been up to that time similar. This is ascribable to the early senescence that occurred in this variety, leading to an underestimate of the number of plants diseased at the last recording. The percentage of plants showing disease symptoms, at any recording before senescence becomes misleading, is thus a satisfactory index of disease development, and hence of susceptibility as measured by external symptoms. Percentage of visibly diseased plants at the last recording before onset of senescence in any one variety provides the most satisfactory index, as being the least subject to "error" and giving the least number of nil values, and this index has accordingly been adopted.

In intensity of infection the 52 blocks fall naturally into 3 groups :

Group 1 ; heavy infection (mean about 70% in the more susceptible strains), 4 blocks.

Group 2 ; light infection (mean about 20% in the more susceptible strains), 18 blocks.

Group 3 ; very light infection (mean rather less than 5% in the more susceptible strains), 30 blocks.

In the following table is given a summarized analysis of data for infection in the 6 varieties in the 3 groups ; in groups 1 and 2 the figures have been transformed to $\sin^{-1}\sqrt{\frac{\text{o\%}}{100\%}}$ wilt, and adjusted by

covariance with $\sin \sqrt[3]{\% \text{ wilt}}$ in adjoining control rows. Group 3 has not been analysed, because of the large number of nil values.

		U.4/5143	A.2106	M.U.8A	BP.50/3	BP.52	B.181	S.E.
Group 1	Degrees (Mean)	59.15	51.11	56.88	56.34	41.96	29.31	± 2.924
	% wilt (Mean)	73.7	60.6	70.1	69.3	44.7	24.0	
Group 2	Degrees (Mean)	25.56	25.31	23.16	27.05	17.01	12.54	± 1.516
	% wilt (Mean)	18.6	18.3	15.5	20.7	8.6	4.7	
Group 3	% wilt (Mean)	3.7	3.7	4.0	3.7	2.2	0.23	

Consistently therefore, in areas of widely varying disease intensity, $U.4/5143 = A.2106 = M.U.8A = BP.50/3 > BP.52 > B.181$, in susceptibility as judged by the proportion of plants showing external symptoms. It was also noted that leaf symptoms appeared much less severe in visibly infected plants of B.181 and BP.52 than in those of the other strains. The order of BP.50/3, BP.52 and B.181 in apparent susceptibility is the same as that recorded in Uganda.

The next table records mean yields of seed cotton per plant in grms. in the 6 varieties, together with unadjusted data for wilt incidence in the same 3 groups.

		U.4/5143	A.2106	M.U.8A	BP.50/3	BP.52	B.181	S.E.	Sig. Diff.
Group 1	Yield (mean) ...	47.7	57.2	63.5	53.2	58.0	57.5	± 4.260	9.26
	Degrees " ...	58.87	53.07	56.35	53.22	41.82	31.37		
	% wilt " ...	73.3	63.9	69.3	64.1	44.5	27.1		
Group 2	Yield (mean) ...	55.3	66.2	70.3	59.3	67.0	61.1	± 1.674	5.20
	Degrees " ...	27.47	24.38	24.02	27.06	16.56	12.01		
	% wilt " ...	21.3	17.0	16.6	20.7	8.1	4.3		
Group 3	Yield (mean) ...	52.0	62.1	62.1	54.3	56.3	51.3	0.23	3.66
	% wilt " ...	3.7	3.7	4.0	3.7	2.2	0.23		

Under conditions of heavy wilt infestation,
 $M.U.8A > BP.50/3$ and $U.4/5143$ in yield of seed cotton, and
 $M.U.8A, BP.52, B.181$ and $A.2106 > U.4/5143$.

Under light infestation,
 $M.U.8A = BP.52 > B.181, BP.50/3$ and $U.4/5143$.
 $A.2106 > BP.50/3$ and $U.4/5143$.
 $B.181 > U.4/5143$.

Under very light infestation,
 $M.U.8A = A.2106 > BP.52, BP.50/3, U.4/5143$ and $B.181$
 $BP.52 > U.4/5143$ and $B.181$.

The remarkable feature of the table is the similarity in yield figures between the groups, especially between groups 1 and 3. There seems to be adequate evidence, both from extensive observation of the results of natural infection and from the results of artificial inoculation, on which to dismiss the inference that wilt had negligible influence on yield. The alternative hypothesis, that the incidence of wilt was closely connected with factors associated with fertility, seems much the more probable.

On this hypothesis, one would expect the apparently relatively resistant B.181 to show the levelling effect of wilt on yield to a less

extent than the other varieties. The data summarized in the table above are in conformity with this expectation, but to a rather limited extent ; the yield of B.181 seems unduly low in Group 1, having regard to the relatively low proportion of plants showing leaf symptoms and the relative slightness of leaf symptoms in the affected plants. This suggests either that the effect of wilt on yield was greater in B.181 than would be suggested by the relatively low incidence of leaf symptoms, or that B.181, under the conditions of the experiment, was inherently less able than the other varieties to respond to the higher fertility levels. In the latter event, it may be that factors governing productive capacity, inherent in the plant as well as environmental, may be closely associated with "resistance." Further study of these possibilities, by fuller analysis of the existing data and by further experimentation, is judged to be a necessary preliminary to any breeding programme for wilt resistance. This problem will be referred to again, in the next section dealing with inoculation experiments.

Other interesting points arising from the analysis of this experiment are : (1) the employment of alternating control rows of a susceptible variety has provided, in the analysis of wilt incidence, a marked gain in precision, especially in the more heavily infested blocks (see the previous tables) ; (2) there is no evidence of any differential effect of the several varieties on wilt incidence or on yield in their adjoining control rows.

Inoculation Experiments.—The effect of a number of methods of inoculation with *V. dahliae*, as follows, on each of the varieties U.4/5143, BP.50/3 and B.181, was determined on plants grown in the field at normal 3 feet $\times$ 2 feet spacing.

ASW1. A small piece of potato saccharose agar culture inserted into the xylem of the main stem, through a longitudinal incision just above ground level, 58 days after planting.

ASW2. As above, 83 days after planting.

AP1. A similar small piece of culture placed on the cut surface of a leaf petiole excised about 1 inch from the main stem, and held in place by a closely fitting sleeve of waxed drinking straw, sealed at the upper end, 58 days after planting.

AS1. Side shoots inoculated on cut surfaces in manner similar to AP1, 58 days after planting.

AR2. Secondary roots inoculated on cut surfaces in manner similar to AP1 and AS1, 83 days after planting.

SS1. 100 ml. of dense aqueous suspension of mycelium, spores and microsclerotia, prepared from maize meal/sand cultures, poured into a hole about 6 inches deep made in the soil alongside the tap root, with deliberate damage to the roots, 58 days after planting.

SS2. As SS1, 83 days after planting.

SS1+2. Inoculated on two occasions, on opposite sides of the plant, as SS1 and SS2.

DS1. In similar holes, approx. 6 inch lengths of the bases of main stems of plants naturally infected during the previous season, split longitudinally, were placed with the split surfaces alongside the tap root.

The above 9 inoculations were applied each to one row (of about 30 plants) of each of the 3 varieties. The inoculated rows were well separated from each other by rows of uninoculated control plants, in none of which did the disease appear. At weekly intervals records were made of the development of external wilt symptoms in the inoculated plants. Yields of seed cotton in the inoculated rows, and in the control rows, were also recorded. The main results are summarised in the following table.

Inoculation method.	U.4/5143.				BP.50/3.				B.181.			
	Plants affected.	Yield per plant (A).	Yield per plant in adjoining control rows (B)	(A) as % of (B).	Plants affected.	Yield per plant (A).	Yield per plant in adjoining control rows (B)	(A) as % of (B).	Plants affected.	Yield per plant (A).	Yield per plant in adjoining control rows (B)	(A) as % of (B).
ASW1	31/31	45	87	52	30/30	45	90	50	30/31	100	114	88
ASW2	32/34	34	60	57	33/33	56	97	58	27/35	59	78	76
AP1	0/34	94	95	99	0/30	98	90	109	0/28	113	103	110
AS1	1/30	70	76	92	2/31	99	90	110	0/36	90	86	105
AR2	9/27	64	80	80	11/33	96	116	83	1/31	80	78	103
SS1	13/30	46	67	69	19/31	71	85	84	14/32	77	95	81
SS2	16/28	53	68	78	16/31	58	90	64	7/31	76	85	89
SS1+2	17/33	44	58	76	26/32	59	97	61	10/30	70	83	84
DS1	0/30	81	72	112	0/32	89	81	110	0/29	84	78	108

In the columns "plants affected" the fractions represent in the numerator the number of plants seen to develop leaf symptoms and in the denominator the number inoculated. Yields per plant are of seed cotton in grms.

Wound inoculation of the main stems has given a high percentage of success, especially on the earlier occasion (ASW1), even in the apparently resistant B.181. In U.4/5143 and BP.50/3 about 75% of the plants of ASW1 were showing symptoms within 14 days, 95% within 21 days, and 100% within 28 days, with yield reduced to about 50% of that in their adjoining control rows; corresponding figures for B.181 were about 70%, 90% and 97%, with reduction in yield of about 12%. The leaf symptoms in B.181 were relatively slight, and there was no marked stunting of vegetative growth as occurred in U.4/5143 and BP.50/3. The later inoculations ASW2 gave a slower development of leaf symptoms: in U.4/5143 and BP.50/3 about 60% within 17 days, 90% within 24 days, 90% again within 31 days, and 97% within 38 days, with 42% loss of yield; corresponding figures for B.181 were 11%, 17%, 40% and 77%, with 24% loss of yield.

The apparently anomalous figures of 12% loss of yield in B.181 caused by the earlier inoculation and 24% loss caused by the later, are illustrative of a potentially large error in the estimates ; occasionally mean plant yields in control rows on either side of an inoculated row differ rather widely. The yield figures must therefore be treated with some reserve.

This experiment was contemporaneous with the variety trial described in the preceding section, early growth was about equally vigorous with that of the most vigorous blocks of the variety trial before wilt started to develop in the latter, and development of wilt in the plants inoculated on the earlier occasion was rather closely contemporaneous with the development of natural wilt in the variety trial. In the light of these observations, the data obtained for B.181 are difficult to reconcile with those of the variety trial, unless it be assumed that the effects of heavy natural soil infestation on yield of B.181 are greater than would be suggested by the comparatively low incidence and relative mildness of leaf symptoms ; and moreover that the effects of heavy natural soil infestation differ from those of stem wound inoculation.

The wound inoculation method as a means of determining the relative reaction of varieties to the disease suffers from two drawbacks ; there is cause for doubt whether its effects on different varieties are parallel to those of natural soil infestation, and the method is slow and tedious. Unfortunately, as shown in the table, other methods designed to be more practicable on a large scale, and in some cases to approximate to natural soil infestation, have given varying and somewhat erratic and uncertain results. The comparative failure of soil inoculation methods, as compared with the high incidence of natural infection in some areas, is remarkable and indicative of the need for much further knowledge of the epidemiology of the disease. Progress in this direction is reported in the next section.

Distribution and Spread.—In 5 blocks each of approx. 1 acre, the progressive incidence of wilt was mapped, the exact position and time of appearance of disease of every visibly affected plant being recorded. One of these blocks had been similarly mapped in the previous season. Analysis of the data obtained leads to the following conclusions :

(1) distribution of disease is typically sporadic at first, followed by the development of areas of relatively dense disease with elsewhere a sporadic and relatively sparse scatter ;

(2) as disease develops, there is a highly significant tendency, *over the area as a whole*, for diseased plants to occur in positions adjacent to earlier diseased plants ;

(3) *within areas of apparently homogeneous disease incidence* there is no evidence of neighbour-to-neighbour spread of disease, such as

would be expected if spread of disease by root contact were to have occurred; the tendency in (2) above is thus due solely to the aggregation of disease into relatively dense patches;

(4) in the field in which cotton was grown in 2 successive years, disease tended to be concentrated in the same areas in each year;

(5) where disease was most concentrated in the first year, it increased in the second, with a tendency for diseased plants in the second year to occur on the sites of plants diseased in the first year;

(6) in areas where disease was more sparse in the first year, there was still less disease in the second, and there was no evidence of any tendency for disease sites in the second year to coincide with those in the previous crop;

(7) in the two instances where observations were sufficiently frequent to show the effect, histograms of plants newly diseased on successive occasions show a double peak, not readily relatable to meteorological conditions and hence suggestive of two overlapping phases, possibly of primary and secondary infection;

(8) while areas of relatively good early growth did not necessarily later show a high incidence of disease, severe disease occurred only in such areas.

Distribution of the disease over the whole Station was also approximately mapped. The observations, as far as they went, are in conformity with the above conclusions; they indicate also that on the Station generally the disease is spreading and in some areas increasing.

From the foregoing it is of course not possible to draw definite conclusions concerning the means of spread and conditions necessary for the development of an epiphytotic. There are, however, sufficient clues to give an enlightened lead to direct experimentation to this end, and future work will be planned accordingly.

Two common means of increase and spread of wilt disease have already been studied in some detail; weed hosts and transmission through the seed. Examinations of common weeds growing in heavily infested areas have given negative results, with one exception. Two plants only of the common weed* *Sida spinosa* L. were found with typical symptoms of a vascular wilt disease, and from these *V. dahliae* alone was isolated. This weed therefore may play some part, though it would appear to be a minor one, in the maintenance and increase of cotton wilt.

Seed Transmission.—37 lots of seed from wilt-diseased plants, comprising 7 lots from artificially infected U.4/5143, 10 lots each from a naturally infected single plant in 7 progenies from U.4 × Sea Island

* I am indebted to the Division of Botany and Plant Pathology, Union Dept. of Agriculture for confirmation of the identification.

hybrids, and 10 lots each subdivided into water-sinking and water-floating but methylated-spirit-sinking fractions, from naturally infected U.4/5143 newly showing symptoms at 10 successive weekly intervals, were sown in a replicated experiment. They were sown in 1-row plots, each having on either side a row of U.4/5143 seed taken from almost certainly wilt-free areas. The experiment covered approximately 2 acres of land, previously under napier grass, selected as being probably free from infestation. 4,078 plants were raised from the seed from wilt diseased plants, and 5,028 from the control U.4/5143. Only 2 plants became diseased during the season; the first observed was in a row of the control U.4/5143, and the second was an adjoining plant from seed of one of the U.4 $\times$ Sea Island hybrids. The results are therefore strongly against the hypothesis of seed transmission.

Much negative evidence of this nature needs to be accumulated before the hypothesis of seed transmission can be regarded as disproved. A weakness in this experiment lies in the fact that plant growth over much of the area was rather poor, although in patches it was good (overall the yield was 620 lb. seed cotton per acre), so that over much of the experiment conditions may have been against visual demonstration of the presence of disease. Also, a wider range of varieties should be covered. The experiment is therefore to be repeated and extended to cover a number of varieties.

BACTERIAL BLIGHT.

Field Experiments.—In order to test susceptibility to angular leaf spot under Barberton conditions, the following 36 strains were planted in 1-row plots replicated 5 times, on loam soil:

U.4/5143

U.4/8161

U.4/88

Cambodia C.9363

M.U.8A

Cambodia $\times$ U.4 hybrids (13 strains)

M.U.8A $\times$ U.4/8161 hybrids (10 strains)

BAR.4/11 = X.1730 hybrid $B_2B_2B_3B_3$

BAR.1730L = " B_2B_2

X.1730A Fully susceptible

BAR.13/1 = 511 (ex S.G.85) hybrid $B_2B_2B_3B_3$

SUS.12/2 = BP.52 Fully susceptible

BAR.12/1 = BP.52 hybrid B_2B_2

X.A.129 Fully susceptible

BAR.11/2 = X.A.129 hybrid B_2B_2

Strains of known genotype in respect of the resistance genes B_2 and B_3 kindly supplied by Dr. R. L. Knight.

9 weeks after planting (early growth was rather slow, after "sticky" germination), one block selected as being of relatively good growth was sprayed with a suspension of *Xanthomonas malvacearum* from very young and vigorous cultures on potato saccharose agar, on two successive days. At the same time, the 8 strains of known

genotype in another block were sprayed with bacterial suspension from dried infected leaves (the quantity available was inadequate for more extensive application). The sprays were applied to the under surfaces of the leaves by knapsack spray pumps, at a rate of about 75 gallons per acre, and in a manner to avoid differential effects that might arise from inequalities in the operators and the machines and in times of application.

After 7 days minute lesions were barely visible on the under surfaces, and were not visible on the upper surfaces until 11 days after spraying. At no time, up to the shedding of the sprayed leaves, was there apparent any material difference between any of the strains in the appearance of the lesions; all strains were graded about 6-7 on Knight's scale, this classification corresponding to B_2 resistance. Results from the application of pure culture suspension were the same as those from leaf inoculum, except that the former gave a greater density of lesions. The incidence of blackarm and bacterial boll disease was very slight; too slight to make worth while any attempt to classify the strains according to damage in these categories.

Under the conditions of the experiment, therefore, the known fully susceptible strains (that is, strains of genotype $b_2b_2b_3b_3$) failed to demonstrate their susceptibility; the genotypes of the 28 local strains tested thus remain undetermined.

A later similar planting on granite soil was abandoned, owing to extreme poverty of growth.

Mean maximum temperatures ($^{\circ}\text{F.}$), mean minimum ($^{\circ}\text{F.}$), total rainfall in inches, and mean hours of sunshine per day were:

- (1) in the week preceding the second day's spraying, 80.4° , 64.5° , $3.15''$ (distributed over 5 days), 2.0 hours;
- (2) in the week following the second day's spraying, 81.4° , 64.2° , $0.15''$, 4.0 hours;
- (3) in the following week, 86.7° , 65.3° , $2.14''$, 6.9 hours;
- (4) in the following three weeks, after which time, most of the infected leaf having shed, observations on lesion development ceased, 85.6° , 65.6° , $2.91''$, 6.2 hours.

These data suggest relatively cool and cloudy weather following the spraying as a possible cause of failure of typical lesion development in the fully susceptible strains.

Field Observations.—In striking contrast to the results of spraying, very severe natural blackarm infection was seen in some progenies of $U.4 \times \text{Sea Island}$ and $M.U.8 \times \text{Tidewater}$, and in a few plants of a plot of *Kapas Purão*. At the other end of the scale, *B.181* in the wilt variety trial showed a conspicuous absence of any phase of bacterial blight, in areas where the other varieties showed angular leaf spot (mostly in the form of lesions bordering the veins) and very mild blackarm typical of normal occurrence of the disease at Barberton.

In view of the evidence obtained here that bacterial boll rot may cause appreciable damage, even where the incidence of angular leaf spot and blackarm is very slight, the possibility of the occurrence of resistance appreciably greater than that conferred by the major genes B_2 and B_3 in Upland cottons seems worthy of consideration. Further work will be aimed at determining the reaction of strains and varieties to all phases of the disease, with the superimposition of various treatments designed to indicate conditions necessary to their development.

INTERNAL BOLL DISEASE.

In my previous season's report, in the section describing boll inoculation experiments with *Nematospora gossypii*, I wrote "The writer's method of inoculation by syringe, of bolls developing normally on plants in the field, has given results exactly comparable with those resulting from stainer inoculation and with the disease as found occurring naturally, and has now reached a stage at which varietal differences can be investigated with some confidence . . . Material from the inoculation experiments described above is in progress of examination to determine the influence of inoculation at varying ages on lock weight, seed weight and lint index. The work is not yet completed, but there is already promise that one or more of these objective measurements may . . . be accurately applicable as an index of susceptibility to staining."

Further work with this material, and with material from the variety inoculation experiment to be described, has fulfilled this prognosis. From the analyses so far made, lock weight provides a satisfactory index of degree of staining, and has been adopted because of the considerable saving in time in avoiding the necessity of hand ginning.

20 bolls of each of the varieties U.4/5143, U.4/6250, A.2106, C.9363, M.U.8A, BP.50/3 and A.4345, were inoculated each in 2 locks by hypodermic needle, with an aqueous suspension of spores of *N. gossypii*, at 4 weeks of age. A further 20 bolls of each of the varieties were similarly inoculated at 6 weeks of age. Throughout development the bolls were protected from insect attack by means of paper bags. At maturity the bolls were collected, and for each boll inoculated at 4 weeks of age the weights of inoculated and of uninoculated control locks were obtained (earlier evidence indicated that there is little if any influence of the disease in inoculated locks on the adjoining control locks). Results are summarized in the following table.

Variety.	Mean Weight uninoculated locks (grms.).	Mean Weight inoculated locks (grms.).	Mean % loss in weight due to inoculation.
M.U.8A	1.033	0.891	13.9
U.4/6250	1.025	0.811	20.2
C.9363	1.393	1.062	22.5
BP.50/3	1.140	0.859	24.6
A.4345	0.994	0.726	26.5
U.4/5143	1.076	0.742	29.8
A.2106	1.272	0.831	32.5

In the material inoculated at 6 weeks it was found that loss in weight due to inoculation, in U.4/5143, was too small in relation to error for statistical significance. The data have shown up a source of error greater than anticipated, arising from unequal development of locks in a single boll. Development on one side of a boll was commonly, and sometimes to an appreciable extent, greater than on the other. In this experiment, as a matter of convenience, two adjacent locks in each boll were inoculated. Errors arising from unequal development of bolls will clearly be much reduced if only bolls of 4 locks are selected for inoculation, and opposite, not adjacent, locks inoculated. For future work the technique will be modified in this way.

Determination of the weight of stained and control locks in the series inoculated at 6 weeks was therefore abandoned. Instead, stained locks from each of the varieties (except A.4345, which is unsatisfactory owing to a high degree of abortion) were set out in rows at random, with their control locks alongside, and 4 independent observers, none in the presence of any of the others and none with any pre-knowledge to give bias to their judgment, were asked to place the 6 varieties in order of degree of staining. Their placings (1 = least stained, 6 = most stained) are given in the following table.

OBSERVERS.						
	Variety.	A	B	C	D	Means.
U.4/5143		5	4	5	5	5
M.U.8A		1	1	1	1	1
A.2106		6	6	6	6	6
U.4/6250		= 2	2	2	3	2
C.9363		4	5	4	4	4
BP.50/3		= 2	3	3	2	3

The close agreement between independent observers, and between their mean order and the order based on loss in weight due to inoculation at 4 weeks of age, is highly satisfactory. Under the conditions of the experiment, M.U.8A and U.4/6250 showed a relatively low, and U.4/5143 and A.2106 a relatively high degree of staining resulting from inoculation by *N. gossypii* in bolls of the same chronological age. It is of interest, and perhaps significant, to note that M.U.8A, and among U.4 types U.4/6250, have the reputation of being particularly good "openers."

These results cannot at present be taken with certainty as indicative of an *inherent* variation in resistance to or escape from the effects of *N. gossypii*. In this experiment, and in the previous season's work, there is evidence to show that, within strains, relatively poorly developed locks show relatively little staining and little loss in weight as a result of inoculation. The possibility that the observed differences between varieties in intensity of staining, may be merely a reflection of differential influence of environment on development of the seed cotton in the different varieties, cannot therefore at present be ruled out.

OTHER DISEASES.

Alternaria was, as usual, common on senescent leaf. During the previous season two species* were isolated; *Alternaria macrospora* Zimmerman and a chromogenic *Alternaria gossypina* (Thüm) Hopk.

In the season under review, two types of leaf spot occurring at a rather early stage, before flowering, were in some areas more common than previously observed. The more common type, but common only on plants of debilitated appearance in poorly grown areas of *hirsutum* cottons, and on *barbadense* cottons generally, was at first a very small, roundish, purple spot, increasing to about 6 mm. diam. and becoming brown with a conspicuous purple border, the brown centre tending to become zoned with relatively dark brown rings. This type constantly yielded *A. gossypina* on plating. The other type, rather less common and having the appearance of being associated with wind damage, comprised light to medium brown dead areas, sometimes with rather vague zoning, involving large areas of lamina between the main veins. The edges were usually indefinite, with commonly a chlorotic border, and with no purple discoloration. *A. macrospora* was isolated regularly from the edges of leaf spots of this type.

A. gossypina has been found also to be associated with a type of staining of seed cotton that, although not common, was rather conspicuous owing to the attractive light carmine colour of the staining.

Another form of staining, olivaceous-grey in colour, was about equally common in natural occurrence and was also much the commonest contaminant in boll inoculations by hypodermic needle. This was associated with *Cladosporium herbarum**.

The *Ganoderma* sp. associated with the slowly spreading death of trees in the *Cassia siamea* windbreaks, has been identified as *G. lucidum**.

PROGRAMME OF WORK FOR 1947-48

VERTICILLIUM WILT DISEASE.

- (1) Field studies of epidemiology of the disease. No definite programme can be laid down under this heading, as the lines of work possible will be governed largely by opportunity.
- (2) Inoculation experiments will be repeated and extended, covering a number of varieties.
- (3) The possibility of seed transmission will be further examined, in a number of varieties.

* I am indebted to the Imperial Mycological Institute for these determinations.

BACTERIAL BLIGHT.

The reaction to all phases of the disease will again be studied of a number of strains and varieties of known genotype in respect to the resistance genes B_2 and B_3 (seed has again been kindly supplied by Dr. Knight). As far as possible environmental conditions will be varied, in the hope that thereby indication will be given of factors necessary for demonstration of full susceptibility.

INTERNAL BOLL DISEASE.

The relative susceptibility of a number of varieties, of a rather wider range of lint and boll characters than were available for last season's experiment, will be determined by an improved technique.

[Included by courtesy of the Southern Rhodesia Government.]

SOUTHERN RHODESIA.

SEASON 1946-47.

INTRODUCTORY NOTE

BY

T. J. NEEDHAM.

Acting Chairman, Cotton Research and Industry Board.

The 1946-47 rainfall season will ever be remembered as one of severe drought which affected the greater part of Rhodesia. In parts, mainly to the south of Gatooma, crop failure occurred over fairly extensive areas.

Inevitably the drought caused a shortage in the maize crop, the staple food of the colony, so much so that it has been necessary to import a large quantity of this commodity.

The food shortage, coming at this time, is a particularly unfortunate event for the country in view of the marked increase in European population through immigration and also the current expansion of industrial development, a combination which has greatly increased the demand for African Labour, which in turn draws heavily on food supplies.

The rapid expansion of the acreage under tobacco also requires much labour. Again, most of the labour employed in this expansion produces no food ; it has to be fed.

Thus, in terms of the fundamental economy of the Colony, in agriculture a marked and sustained increase in the production of maize is the first essential. Secondly, tobacco growing is being encouraged because of this crop's dollar conserving value.

Compared with maize and tobacco on a present-day monetary basis, cotton growing by Europeans is definitely not as attractive. But it may here be noted that a little more than twenty years ago, the last occasion on which the price of cotton was about 1s. 8d. per lb. of lint, as it is at present, there was a boom in cotton production. The reason why there is no such tendency today is to be found in the fact that some twenty years ago the price of a 200 lb. bag of maize was about 10s., whereas, today the price locally is 30s.

There is no reason, except that of comparative cash value returns for different crops, which militates against the expansion of cotton growing. This is shown by the fact that the crop is grown year after year by a number of farmers who admit that cotton pays for the growing, not only in the cash obtained for the lint, but also on account of the rotational benefits accruing to maize following cotton and for the feeding value of the cotton seed.

Admittedly present mean yields of cotton per acre are not as high as those obtained in the cotton belt of the United States of America, but Rhodesian yields compare favourably with those obtained in many parts of Africa where cotton is a rain-grown crop. In this connection attention may be drawn to the yield and cash return figures from a group of unselected African growers in the Mondoro area, an account of which is given in the following report by Mr. McKinstry. It is sensed that as the value of the cotton crop in mixed farming becomes better known to Africans, there will be a steady and sustained increase in production from this source. With the continuous encouragement given by Land Development Officers we may hope for the time to arrive when the African cotton crop will definitely increase. The Mondoro example is a case in point.

The value of African grown cotton to the Colony from an economic point of view needs no emphasis and, as the labour for growing the crop would probably be drawn mainly from women and adolescents in the Native Areas who are almost entirely idle at present, the general labour market should not suffer in any way.

Southern Rhodesian natives are as intelligent cultivators as those of neighbouring territories, but the memory of jassid damage to the crop in the early years probably still lingers in their minds.

Owing to the labours of Major Cameron and his technical staff for the past twenty years, however, a type of cotton is now available which offers a better resistance than was possible in those days.

The main lines of work at the Cotton Station are, firstly, maintaining a high standard of jassid resistance and earliness in strains coupled with desirable lint and seed characters ; and secondly, seeking ways and means of increasing yield per acre by investigations in which the aim is to reduce damage due to bollworms in the crop.

Mr. McKinstry's report gives an interesting account of the wide range of experimental work in progress at the Station.

COTTON RESEARCH STATION, GATOOMA. PROGRESS REPORT FOR THE SEASON 1946-47.

BY

A. H. MCKINSTRY.

Planting period	...	...	Third week of November, 1946.
Flowering	...	...	Mid-January to Mid-March, 1947.
Picking	...	...	May-June, 1947.
Legal Uprooting Date	...	...	30th September, 1947.

METEOROLOGY.

Drought conditions dominated the whole of the 1946-47 season, and except for comparatively small areas in the North and East, rainfall over most parts of the Colony was meagre and very badly

distributed. Climatically Gatooma was representative of an intermediate zone : smaller areas to the North had better rains, while larger areas situated South and South-West of Gatooma suffered crop failures.

The total rainfall for the period 1st November to 30th April was 16.51 inches, the lowest on record since the Station was started twenty-two years ago.

At the Station, cotton was planted during the third week of November on the first suitable rains of the season. About two thirds of the crop braided normally, but owing to inadequate " follow on " rainfall the remaining third did not braid until about the end of the first week in December.

Maize planting took place over a longer period than usual, in December and early January, again due to sparse and erratic rainfall.

Rainfall was no better during the growing and crop-making periods than at planting, and in consequence crops suffered from drought-like conditions throughout their development.

In the winter months, in June and July, there were three periods of a few days each when minimum temperatures were not far above freezing-point. Reports of early-morning frosts in low-lying areas were not uncommon.

AGRICULTURAL SYSTEM.

Compost and Cotton.—Applications of compost at the rates of five and ten tons per acre increased cotton yields, though this season these increases were not statistically significant. Applications of potash had even less effect than compost. Of three bulk fields planted to cotton, the two which received compost gave better yields than the one which did not.

Rotational Value of Cotton.—This season the value of cotton as a rotation crop in increasing the yield of the following maize crop was not apparent, a season in which maize yields were of the order of only two bags of grain per acre. (One bag=200 lb. grain.)

Grasses.—Considering the very difficult climatic conditions, *Panicum Makarikari*, Mount Elgon Star, No. 2 Star, and Napier Fodder, mentioned in last season's report as being promising grasses, all made surprisingly effective growth when transplanted this season in fair-sized multiplication plots.

Two strains of Napier Fodder, one originally from the Gold Coast and the other from the Cameroons, but both obtained from the Grassland Research Station, Matapos, made strikingly vigorous growth.

Two seasons' observations on a limited number of grass types have demonstrated that material is available for the marked improve-

ment of indigenous pastures. There is little doubt that introduced grasses will feature with increasing importance in Rhodesian mixed farming. On the Station the more promising of these grasses for local conditions are being multiplied, but a number of seasons will be necessary before their value can be tested fully for grazing or in rotation with the principal crops.

AGRICULTURAL PRACTICES.

Treatment of Cotton Seed.—Neither plant stand nor yield in cotton was increased by treating acid delinted cotton seed before planting with either “Agrosan” or different powder preparations containing D.D.T. or “Gammexane”.

COTTON PLANT DEVELOPMENT.

Despite the difficulties of the season, good to excellent plant stands were obtained at the commercial spacing.

Flowering commenced in mid-January, and reached its peak during February ; but by mid-March the rate of flowering had declined to a low level.

The shedding of young squares before flowering and of buds and young bolls during the first few weeks of flowering was very pronounced. Again, for the third season in succession, this loss in the all-important early crop was caused almost entirely by Sudan bollworm attack.

The major portion of the crop picked was made from flowers produced during the period mid-January to mid-February.

Bolls matured both early and quickly this season. The first bolls to split normally were recorded in early March, and by mid-May the crop was fully mature. There was a certain amount of fouling by rain-splashed dirt of the earlier split bolls, caused by showers which fell about the end of March.

Both cleanliness of seed cotton and seed soundness have been of a very high standard in the commercial crop ; the latter surprisingly so, in view of the drought conditions in which the crop grew.

Yields.—Final growth in the Station's crop was only about two feet high, but the fruiting scaffold developed carried crops of about 450 lb. seed cotton per acre in wide-spaced bulks in which Sudan bollworm damage was moderately heavy. In the Variety Trials, at the commercial spacing, the highest yields were 600 lb. seed cotton per acre.

Similar growth over a twenty acre field on an adjacent farm yielded 600 lb. seed cotton per acre from one half of the field where bollworm damage was comparatively light, but only some 200 lb. seed cotton per acre was harvested from the other half of the same field where bollworm damage was heavy.

Details have been supplied, through the courtesy of the Land Development Officer, of the results obtained in the Mondoro African Farming Area in the Gatooma-Hartley district. These illustrate the very useful returns obtained in a difficult season :—

Total number of growers (unselected), 107 Africans.

Mean yield per acre approximately 550 lb. seed cotton.

Mean cash return per grower approximately £10.

Furthermore, one of the growers received a gross income of just over £47 for his crop, which was grown on a total of 1·2 acres ; this crop having yielded at the rate of approximately 2,000 lb. seed cotton per acre. Of other growers one received £40, five £30, and twelve £20, while a number realised between £10 and £20 for their crops. In each instance about one acre of cotton was cultivated.

Ninety-one per cent of the seed cotton from Mondoro was placed in Class 1, the cleanest of the four Classes on the basis of which all seed cotton is bought.

It may be mentioned also that the price paid for Class 1 seed cotton grown by African farmers in the 1946-47 season was 4·75 pence per pound.

COTTON BREEDING.

The main factors which caused crop loss this season were Sudan bollworm attack and the drought. Of the two, the loss due to bollworm was probably of greater importance.

As expected, where growth was better and Sudan bollworm damage less, yield differences between strains were greater. In Table I are given the results of the one repetition of the Main Variety Trial in which the heaviest yields were obtained. In the other two repetitions of this trial yield differences between strains were not as well defined due to the greater adverse effect of the main limiting factors on yield.

In this trial, however, the order of yield of the strains in all repetitions is similar. Thus among the first four strains are placed 12405 and 12204, two derivatives of the Gatooma U4 × Cambodia crosses, and also 9L34, the strain at present in commercial cultivation. This result is in general agreement with that obtained in the 1945-46 season.

TABLE I.
COTTON STRAINS TRIAL.

<i>Ancestry of Strains.</i>	<i>Strain Numbers.</i>	<i>Yield Lint per Acre in lb.</i>
(64/7/10 × Cambodia) × 64/7/10	12405	211
64/V/No. 3	9L34	204
(64/7/10 × Cambodia) × 64/7/10... ..	12204	185
9L34	12437	178
(64/7/10 × Cambodia) × 64/7/10	12490	166
64/7/10/1	7L1	161
7L5	12219	158
9L34	12438	154
Difference required for Significance at P = 0·05 =		14

In another strain trial of which there were two repetitions nine Barberton strains were compared with 9L34 and 12204. Of those of the Barberton strains which were of $U_4 \times$ Cambodia origin, some were straight crosses, and some backcrossed to U_4 . In both repetitions of this trial Barberton strains A292, A2106, and A255 were placed among the first four for yield. Previously the Barberton strains of ($U_4 \times$ Cambodia) $\times$ U_4 origin, grown annually in observation plots since 1943-44 season, have been regarded as poor finishers. This is the first time that these strains have appeared in a variety trial at Gatooma.

In future greater attention will be paid to the behaviour of these strains, and selections will be made from a number of them.

In addition to the selections which are being taken from the Gatooma U_4 and the Barberton material, other selections are being made among quality crosses of either $U_4 \times$ Sea Island or M.U.8 $\times$ Tidewater parentage, most of the seed of which was obtained from Barberton for planting in the 1945-46 season. It is yet too soon to make a report on the possibilities of this plant breeding material.

F_1 seed of M.U.8 $\times$ Tidewater generously given by F. R. Parnell was grown under irrigation. This plot will be maintained as a source of F_2 seed.

COTTON PESTS.

Jassid.—This pest was very little in evidence during the season.

Except in part of the 1945-46 crop, jassid attack on the Station's crop has been light in the past three seasons. Selection for jassid resistance has therefore been based on judgment of leaf hairiness and not on the relative amount of damage caused to different strains by the pest.

American Bollworm.—Extremely few larvæ of this pest were to be found in cotton.

Among the factors which probably accounted for the almost complete absence of the pest in cotton is the fact that, due to poor rainfall distribution, the planting period of the maize crop was more prolonged than usual. This resulted in a protracted tasselling period which, in turn, probably "held" the American bollworm moths' egg laying which might otherwise have taken place in cotton. The attack in maize was well-defined.

Secondly, as cotton flowering was on the wane at about the time that the main flight of maize-bred moths was calculated to be in progress, the crop proved unattractive.

Records taken for the first time this season in a number of fields show that 91 per cent. of the total larval population was found at the tips of the cob and a further 6 per cent. on the cob body itself. Again, it was noted that the main pupation site is within the tip of the cob. These results are similar to observations made at other stations.

Therefore, in experiments to reduce American larval populations in maize, and so to control the main moth flight to cotton at its source, the application of treatments under trial may best be concentrated at the cob tips.

Thus in one experiment cob tips were treated at the silking stage with 5 per cent. D.D.T. in the form of "Guesarol M" wettable powder, or with "Agrocide 3" a dust containing 0.65 per cent. Gammexane; in other plots of the experiment cob tips were left untreated. Unfortunately the numbers of larvæ (which were frequently observed but not removed) were too small for comparisons between treatments to be worth-while. On the basis of yield, however, the untreated plots gave the heaviest yield of grain; but this result was not statistically significant.

In another experiment a comparison was made of the size of larval populations in existence on strains of maize having either mostly exposed cob tips or mostly well-covered tips. During the course of record-taking it became apparent that larval maturity takes place in advance of the development of the degree of exposure of the cob tips. The tips were mostly well-covered by the enveloping sheath during the course of larval feeding even in the strain with inherently exposed tips. It seems unlikely therefore that the size of the American bollworm population which matures on maize will be influenced by the degree of exposure of the cob tips. Previously it had been assumed in theory that strains of maize with exposed cob tips might possibly either favour high larval survival by allowing the larvæ to have ready access to food in the developing grain, or conversely, that larvæ while feeding on exposed tips would themselves tend to be more exposed and vulnerable to attack by their natural enemies.

Sudan bollworm.—(*Diparopsis castanea*). As in previous seasons, the loss of young squares was caused almost exclusively by Sudan bollworms. The loss was greater this season as larvæ were more numerous than in the 1944-45 and 1945-46 seasons.

A few Sudan bollworm eggs were found on the young cotton seedlings two to three weeks from brairding. Two weeks later, when the first flower squares were being produced, larvæ were recorded at the rate of one per plant. At this stage in the plants' development the small larvæ attacked mostly the growth buds of branches and main stem, thus causing damage and delay in the formation of the fruiting scaffold. By the time that flowering had commenced several full grown larvæ had been taken in the crop. Subsequently, there was little abatement of the attack by this pest throughout the season.

About 10 per cent. of the locks of mature bolls showed damage due to bollworm punctures.

Counts of overwintering pupæ in unploughed cotton lands in July and August showed that there were 2,000-3,000 Sudan bollworm pupæ per acre, the vast majority of them being found in the uppermost four inches of the surface soil. Similar counts in the winter months of

1946 revealed overwintering pupæ populations of about 24,000 per acre.

Towards the end of September a small amount of egg laying which occurred in certain experimental cotton plots represented the first signs of recrudescence of the pest.

Once again it may be emphasized that control measures which reduce Sudan bollworm damage in the early crop would probably result in an appreciable and lasting increase in the mean yields of seed cotton per acre. To this end the following experiments are in progress:

Photoperiodic perennials, at present represented only by a small number of plants of a rather mixed type known as Ecuador 5, are being tested as plant-traps for the early Sudan bollworm egg laying in the November-January period. Fairly heavy egg laying took place on them this season, as at this period the plants, in their second year of growth, were vegetative. No larvæ developed fully, though small ones were seen, until the plants commenced to bear large buds and young bolls in April and May.

Propagation of Ecuador 5 is in progress, quite a number of bolls having been obtained from the few plants despite the fact that fruiting occurred in the winter months. In an attempt further to increase the supply of seed other plants are being grown in an area of lower altitude where winter temperatures are higher.

An immediate expansion in the use of Ecuador 5 or other photoperiodic cottons as plant-traps for the early Sudan bollworm egg laying is not contemplated until further experience has been gained in the management of a larger number of plants at the Station.

In other experiments the possible usefulness of different formulations of D.D.T. and "Gammexane" are being tested. Due to the late arrival of stocks the first application of these insecticides were unavoidably delayed until mid-March. Flowering had by then declined to a low level. Despite this fact, the results given in Table II indicate that the use of either "Guesarol M" or "Agrocide 3" has increased yields of seed cotton per acre significantly at $P=0.05$. In the circumstances, this result should be regarded with reserve until other similar experiments have been done. In the experiment, however, plant development in any form was unaffected by the insecticides applied at this late stage of growth.

Next season (1947-48) it is intended to apply these insecticides during the young seedling and flowering stages of plant development.

TABLE II.

D.D.T. AND "GAMMEXANE" TREATMENTS APPLIED TO COTTON
IN A TRIAL OF 8 RANDOMISED BLOCKS TOTALLING 3.3 ACRES.

Treatments.	Yield of Seed Cotton per acre in lb.
"Guesarol M", a D.D.T. wettable powder	370
"Agrocide 3", a "Gammexane" dust	366
No treatment control	329
Difference required for Significance $P = 0.05 =$	24

TABLE II NOTES.

1. On 11/3/47, 0.05 per cent. D.D.T. as "Guesarol" applied at 40 gallons per acre rate and 0.65 per cent. "Gammexane" as "Agrocide 3" applied at 9 lb. per acre rate.
2. On 15/4/47 0.5 per cent. D.D.T. as "Guesarol" applied at 40 gallons per acre rate and 0.65 per cent. "Gammexane" as "Agrocide 3" applied at 12 lb. per acre rate.
3. Flowering had practically ceased by 11/3/47 but showers of rain at the end of March induced a small flush of flowering in this field.

In yet another series of experiments the aim is to reduce considerably the overwintering pupal populations either by mechanical tillage or by applying fumigants to the soil. Thus, a large-scale trial is in progress to test the comparative efficiency in the destruction of pupæ of a disc harrow, a plough, and of a power-driven Fishleigh rotary cultivator, recently imported specifically for this experiment. In other trials D.D.T. and other fumigants have been applied to the dormant pupæ in insect cages and in the field. Final results from these experiments are not yet available.

Control measures which might prove to be economically valuable in the destruction of overwintering pupæ would have the advantage of the static condition of the pest as well as of rainless conditions.

Spiny Bollworm.—Few larvæ were found during crop-making by the plants, but populations of the pest tended to increase moderately in May and June. More recent observations in September indicate that Spiny bollworm is the only pest to be found fairly readily in both the annual cotton and in Ecuador 5 plants.

Cotton Stainers.—The number of stainers in the crop remained small until about the end of March. Thereafter the pest showed a definite but gradual increase, culminating in an unimpressive population peak in June.

D.intermedius was more numerous than *D.fasciatus*, while only an occasional specimen of *D.superstitiosus* was taken in the crop.

Approximately 90 per cent. by weight of the Station's crop was classified as unstained seed cotton.

In April and May several exploratory tests were made with different D.D.T. and "Gammexane" formulations in the control of stainers in the field. The insecticides were either sprayed or dusted on groups of plants, or they were incorporated in different forms of bait traps in which cotton seed was the attractant.

In general, the results of these tests indicate that one application to the plants of 5 per cent. D.D.T. in the form of "Guesarol M" wettable powder killed stainer adults and nymphs over a period of at least a month. Again, the D.D.T. preparations when incorporated in traps did not repel stainers to the same extent as did the dusts containing "Gammexane."

In particular, "Guesarol M" containing at full strength $33\frac{1}{3}$ per cent. D.D.T., when mixed with cotton seed cake formed a potent poisoned-bait. In the mature crop, nymphs were observed to crawl upwind for a distance of about six yards to feed on the "Guesarol" treated cake which had been broadcast over a limited area. There was heavy mortality of the nymphs.

The efficiency of the poisoned cake did not appear to decrease on drying after it had been purposely wetted.

Cotton seed cake from which about 80 per cent. of the oil had been expressed proved more attractive in these preliminary tests than coarsely-crushed acid-delinted seed, but in turn this type of seed was more attractive than whole fuzzy seed.

Circumstances permitting, trials in which the D.D.T. treated cake is broadcasted will be made next season coincident with the arrival of the immigrant stainer population.

The mobility of stainers and the delayed-action killing qualities of D.D.T. are major uncontrollable factors affecting population counts of stainers in field experiments of this nature.

Aphis.—The first signs of aphid honey-dew stickiness were observed about mid-March on groups of plants; but there was no general attack by this pest during the season.

Termites.—Termite damage, except in one small area of the farm, was negligible.

Other Insect Pests.—The chrysomelid beetle *Monolepta* near *morio* Jac. was recorded for the first time as a potential pest. This insect damaged quite severely the leaves of cotton plants in the early stages of flowering. The attack was confined to small areas in the annual crop, in keeping with the numbers of the pest. The beetles were controlled readily by dusting the plants with "Agrocide 3". Apart from cotton, the beetles were found feeding on Soya beans and in the surrounding veld, on *Lonchocarpus capassa*.

Adults of *Apate monachus* F, apparently a common species of catholic tastes, attacked the large woody stems of a number of the Ecuador plants in September.

Various *Tenebrionidae* were killed, seemingly quite easily, by the D.D.T. preparations applied in different experiments.

MYCOLOGY.

Alternaria macrospora.—The object of two large-scale experiments, designed to compare the effects of various potash and/or compost

treatments in hindering the development of *Alternaria*, was not achieved, due to there being an insufficient natural infection by the organism. It was not found possible to infect the plots artificially.

SUMMARY AND CONCLUSIONS.

Drought conditions dominated the 1946-47 season. The Gatooma area was representative of an intermediate zone, to the North and East of which rainfall was better, but to the South and West of which large areas suffered crop failures.

Drought conditions throughout the season served once again to emphasize the drought-tolerant qualities of the cotton crop as compared with maize.

Sudan bollworm was the only pest of importance on the Station. The attack by this pest lasted throughout the life of the plants, and, in general, was heavy. Where attack and damage by the bollworm was least severe, yields ranged from 450-600 pounds of seed cotton to the acre, despite drought conditions.

The main investigations connected with increasing yields per acre are aimed at the control of Sudan and American bollworms. An account is given of the work in progress.

Yield returns from the Main Variety Trial confirm those of the previous season, that derivatives of the 7Cs (Gatooma U₄ × Cambodia) × U₄ are as good as, or possibly better than 9L34, the strain at present in commercial cultivation and a descendant of the original U₄ material.

A number of Barberton strains, also derived from U₄ × Cambodia crosses, were grown in trials for the first time this season at Gatooma and yielded well.

Several grasses under observation in small plots during the past two seasons show definite promise of being an improvement on local indigenous types under rain-grown conditions.

PROGRAMME FOR 1947-48.

Attention will be paid mainly to the following in the programme of experiments :—

- (a) Control measures against Sudan and American bollworms.
- (b) Maintaining a high degree of jassid resistance in strains, in conjunction with earliness, prolific fruiting and desirable seed cotton qualities.
- (c) Testing the effect of potash and compost applications which may hinder the development of *Alternaria* in cotton.
- (d) Introducing rain-grown grasses which may be of benefit in the agricultural system with cotton, and multiplying the most promising of these grasses.

ANGLO-EGYPTIAN SUDAN.

PROGRESS REPORT OF THE
PLANT BREEDING STATIONS, SEASON 1946-1947.

BY

R. R. ANSON, R. L. KNIGHT, S. H. EVELYN AND M. F. ROSE,

PLANTING AND PICKING DATES.

<i>Area.</i>	<i>Average Planting Dates.</i>	<i>Average Picking Dates.</i>	<i>Close Season.</i>
Gezira	10th Aug.-15th Sept.	30th Dec.-1st April	15th April-10th Aug.
Gash Delta	20th Aug.-20th Sept.	10th Jan.-30th April	30th April-20th Aug.
Tokar	7th Sept.-15th Oct.	1st Jan.-31st May	1st June-20th Aug.
Kordofan	15th June-15th Aug.	15th Oct.-1st March	1st March-15th June
Zeidab	1st May-15th May	1st Sept.-30th Sept.	1st Jan.-30th April
Equatoria	15th May-31st Aug.	1st Oct.-15th Feb.	—

INTRODUCTION.

Cotton breeding for the Gezira is governed by the crop history of the tract. In the early years blackarm and leaf-curl were responsible for heavy losses in yield per acre. Recovery from these very low yields and the establishment of a satisfactory degree of stability were achieved by the rigorous application of plant sanitation measures devised by the research officers of the Department of Agriculture and Forests. These included the introduction each year of blackarm-free seed from Egypt and latterly from the Gash, the disinfection of this seed, an increase in the length of the fallow in the rotation, a delayed sowing date, the uprooting and burning of the old cotton plants together with plant debris, and the use of a leaf-curl resistant variety in the worst affected area.

Except for the last mentioned, all these measures are expensive to carry out and require an immense amount of difficult supervision. Their relaxation would inevitably lead to a severe reduction in yield per acre. To these problems has been added the jassid, an insect pest which has attacked the northern Gezira crop heavily in recent years. The attack can be checked by spraying; this was carried out on an extensive scale last season and is to be repeated. But this again adds a large charge to the cost of producing the crop.

Varieties resistant to blackarm, leaf-curl and jassid have long been known, but the existing crop varieties in the Gezira have such a valuable market reputation that the substitution of disease resistant varieties of other qualities would be unthinkable, except as a desperate measure to avert utter disaster. It follows that in the Gezira, the task of the cotton breeder is to add to the existing commercial varieties genes for disease and pest resistance without altering in any appreciable way their technological characteristics.

This task is undertaken in two stages. The problems in applied genetics involved in the transference of genes for disease resistance are dealt with at Shambat. At Medani, high grade stocks are selected

from the commercial varieties (Domains Sakel and Xi730) for use at Shambat as parents. As resistant lines are received from Shambat they are tested, and when necessary, final selections made ("filtering") to bring the quality of the new material right into line with that of the old types to be replaced.

Cotton breeding in Kordofan is concerned with American Upland cottons. The crop is not grown in such a densely cultivated area, and diseases and pests do not usually rise to disastrous proportions. Nevertheless, blackarm resistance is of great importance and is tackled in the same way as in the Gezira. The main breeding problem, however, is to combine extreme earliness with good yield and satisfactory quality.

The purification and multiplication of crops other than cotton is now being undertaken, and is centred on Medani.

VISITORS.

Mr. E. O. Pearson visited the Cotton Breeding Stations during the course of a tour of the cotton growing areas of the Sudan.

Messrs. A. G. Bebbington and A. N. Prentice passed through the Sudan during the last week of January, 1947, on their way back to Tanganyika from leave in the United Kingdom and were able to get a brief glimpse of the cotton breeding work at Shambat and Wad Medani.

Mr. Mayer of the Cyanamid Products Company visited the Gezira Research Farm on 28th January, 1947.

THE GEZIRA STATION.

METEOROLOGY.

Rains were somewhat earlier than usual, but the first showers, which fell in March, were followed by a dry spell in April and a small recording in May. The wet season closed down in October. The average monthly readings were :—

	Average max. °C.	Average min. °C.	Total rainfall.	Average hum. 8 a.m.
1946.			mm.	
January	35.0	14.9	—	36
February	36.4	16.3	—	26
March	38.5	16.9	3.9	18
April	40.8	20.1	—	14
May	42.2	23.0	1.3	21
June	38.6	24.7	29.9	52
July	35.2	22.9	159.6	73
August	32.4	21.7	125.6	76
September	35.5	21.7	86.6	74
October	37.7	22.6	17.9	61
November	36.9	18.6	—	35
December	35.6	15.1	—	37
Total			424.8	
1947.				
January	33.3	13.0	—	32
February	36.4	14.5	—	22
March	37.8	15.1	—	17

BREEDING AND VARIETY TESTING

BY

S. H. EVELYN.

BREEDING.

The breeding plot was sown about a fortnight later than usual (25th August). The plot itself (plot 66) is of poor fertility ; it is on a 3-course rotation. A heavy termite attack necessitated resowing on 7th September, 1946, and again on 29th September, 1946. Germination and growth were patchy and an initial blackarm attack caused a fair amount of shedding of first formed sympodia, which reduced yields and made the recording of node numbers difficult. The most striking features of the season were the extremely low values recorded for seed cotton and lint per boll, number of seeds per boll, lint index, seed weight and ginning outturn of all varieties and the relatively high values recorded for node number* in the Domains Sakel.

These all go to demonstrate that the plants were never really happy, and to support the theory that a high percentage of the first formed buds were lost through blackarm. A season such as this, however, has one advantage and that is that the most adaptable plants automatically select themselves.

The following material was sown and worked on :—

Domains Sakel.

- (a) 44 single plants, selected for high yield and high lint index were propagated in progeny rows. Some of these appear very promising.
- (b) 14 single plants were selected for low node number (6-8) and grown as progeny rows. Many of these have bred true for low node number in spite of the conditions and are being carried forward.
- (c) A refilter of D.S.1 was grown to determine whether an improvement in regularity could be obtained. A sample has been submitted for hair and spinning tests in comparison with like samples of Commercial Domains Sakel and original D.S.1.
- (d) A bulk of D.S.2 was grown and filtered—the results are not yet available.
- (e) Selfed seed of 44 single plants of the previous season with a mean lint index of 5.7 grm. (cf. Domains Sakel at 5.1 grm.) was bulked to form D.S.3. The mean of three 100-boll random bulk samples of D.S.3 gave a lint index of 5.4 grm. as against a comparable mean for D.S. at 5.0 grm. A small bulk of 1 feddan of D.S.3 will be grown next season at the Barakat Seed Farm. Lint samples have been submitted for testing.

*"Node Number" represents the position of the lowest effective sympodium, the cotyledonary nodes being included in the count.

- (f) Selfed seed of 14 progeny rows all with improved yield characters was bulked to form D.S.4. Mean values of three 100-boll bulk samples of each were as follows :—

			Seed cotton per boll	Lint per boll	No. of seeds per boll	Seed wt. grms.	Lint Index	Ginning Outturn
D.S.	...	...	3.00	.84	16.6	13.0	5.0	27.8
D.S.4	...	...	3.03	.86	16.4	13.3	5.2	28.4

A feddan of D.S.4 is also being bulked up next season at Barakat Seed Farm for testing against D.S.

X.1730 Series.

- (a) 35 single plants were selected after analysis of 300 random plants of X.1730A, and were grown as progeny rows. Those rows passing the regularity test will be bulked to form the first filter of X.1730A.
- (b) A bulk of X.1730K was grown for filtering. In general characters and lint quality K is better than A and it will be bulked in the coming season to obtain seed for testing against A. Lint samples of both are being compared this year by the Shirley Institute.
- (c) Bulks of BAR.1730L and its Selections 1 and 2, BAR.4/5, BAR.4/8, BAR.4/9 and BAR.4/11 were grown for filtering for higher yield. Single plants of these varieties selected for yield were grown as progeny rows. A first filter of BAR.4/11 was also examined.

These filtered strains will be propagated separately at Hamad el Nil to obtain seed for future variety tests.

Hairy X.1530.

A small bulk of this strain was grown for filtering. In past seasons it has shown slightly more resistance to jassid attack than X.1730A and obtained a better spinning report. It is heavier yielding and by selection is now equal in staple length to X.1730A and, though still segregating for degrees of hairiness, is much purer for this character than when first worked on. The most hairy plants were selected this season and selfed and the best of these will be bulked for propagation at Abdel Magid next season to obtain seed for varietal tests. Lint samples of this strain and X.1730A have been submitted to the Shirley Institute for spinning tests.

LEAF-CURL RESISTANCE.

This season the leaf-curl resistance selection experiments were divided into three sections :—(a) A major experiment on the same lines as in past seasons (See E.C.G.C. Prog. Repts. from Expt. Stations, Season 1941/42, p. 69), (b) An observation plot of bulked selfed seed of the four most resistant families grown in rows alternated with rows of 'Spreader' material and (c) The same four families plus a control of Commercial Domains Sakel, grown in a randomized block with 8 replicates, at Shambat. In this experiment 'Spreader' plants

surrounded each selected plant as in (a) and *Dolichos* belts surrounding the whole experiment were cut when Whiteflies were thought to be sufficiently numerous and the Whiteflies driven into the plot. The total infection reached at 11th April, 1947, was only 38.3 per cent. Selected or R plants infected were 128 out of 400 or 32 per cent and the Spreaders (S. plants) were 178 out of 400 or 44.5 per cent. Differences were not significant.

(a) *Gezira Research Farm, Plot 66.*—The major experiment consisted of eight resistant Domains Sakel progenies, one resistant Massey's Domains Sakel progeny and a control of commercial Domains Sakel. The randomized block layout was employed as usual with 10 replicates and the experiment was sown late, on 18th September, 1946. A severe attack of termites necessitated a resow 11 days later. The disease was not recorded in the experiment until 10th December, 1946. Incidence was recorded fortnightly from this date until 31st March, 1947.

The following table illustrates the incidence :—

Date.	Material.	No. of Plants.	No. infected.	% infection.
21st January, 1947	R. plants	396	58	14.6
"	Controls	43	40	93.0
"	Spreaders	411	368	90.0
31st March, 1947	R. plants	396	283	71.3
"	Controls	43	43	100.0
"	Spreaders	411	396	97.3
"	Gross Infection	850	722	84.9

From the gross infection it will be seen that the disease was widespread and so block differences were not significant, although as in all past seasons the infection started in the north-east corner of the plot. The main interest lies in the fact that the resistant selections at the end of January showed an infection of only 14.6 per cent. as against the control at 93 per cent. and the surrounding spreaders at 90 per cent. At this date the crop had already been picked twice and so any subsequent attack could have little or no effect on the crop. Further, although the infection increased to 71.3 per cent. at the end of March as against 100 per cent. for the control and 97.3 per cent. for the spreaders, the degree of infection on the R. plants after the end of January was so slight that it would only be detected by minute examination, whereas in the control and spreader material it was obvious at a distance. The results follow :—

PERCENTAGE OF LEAF-CURL INCIDENCE AT 21ST JANUARY, 1947.

No. 2 RDS	No. 3 RDS	No. 4 RDS	No. 5 RDS	No. 1 RDS	No. 8 RDS	No. 9 RMS	No. 6 RDS	No. 7 RDS	No. 10 Control. Dom. S.
8/2/1—2 2.0	8/2/6—1 2.0	8/2/6—5 8.0	8/2/8—2 8.5	8/2/1—1 10.0	8/2/9—1 13.0	1/1/1—3 19.0	8/2/8—3 24.0	8/2/8—5 36.3	93.5
87.2					91.0		84.7		95.5
97.5			90.0		82.2		87.0		97.7
91.5									

The infection of the corresponding spreader plants surrounding each progeny is given below the main data for comparison.

A difference of 16.1 per cent. was significant at the 0.1 per cent. level. Progenies within the same bracket do not differ significantly. All selections were significantly more resistant than the control.

PERCENTAGE OF LEAF-CURL INCIDENCE AT 31ST MARCH, 1947.

No. 1 RDS	No. 3 RDS	No. 7 RDS	No. 8 RDS	No. 4 RDS	No. 2 RDS	No. 6 RDS	No. 5 RDS	No. 9 RMS	No. 10 Control. Dom. S.
8/2/1—1 54.0	8/2/6—1 59.2	8/2/8—5 69.0	8/2/9—1 69.7	8/2/6—5 71.8	8/2/1—2 72.7	8/2/8—3 73.0	8/2/8—2 74.0	1/1/1—3 93.5	100.0
100.0	98.0	93.0	96.0	94.7	97.5	100.0	97.5	100.0	97.5

The infection of the corresponding spreader plants surrounding each progeny is given below the main data for comparison.

A difference of 22 per cent. was significant at the 1 per cent. level. Progenies within the same bracket do not differ significantly. All Domains Sakel selections were significantly more resistant than the control. The Resistant Massey's Domains Sakel was not significantly better than control at 31st March, 1947, although significantly more resistant than the control at 21st January, 1947.

The best R.D.S. progenies will be tested in the same way in the coming season, and duplicates will be sown as progeny rows at the normal date, for laboratory analysis, and for hair and spinning tests. A bulk of the best single plants which remained entirely free from the disease at 31st March, 1947, will be sent to Dr. Knight as female parent for the inclusion of blackarm resistance genes.

(b) *Gezira Research Farm Plot 66.*—In this minor experiment, separate bulks of selfed seed of families R.D.S.8/2, R.D.S.3/5, R.D.S.3/4 and R.M.S.1/1 were grown and each alternate row was sown with spreaders. Holes were examined fortnightly and those showing the disease were tagged. The results given below are striking:—

PERCENTAGE OF HOLE INFECTION AT 25TH JANUARY, 1947.

	Selection.	Spreader.
R.D.S. 8/2 ...	11.6	98.3
R.D.S. 3/5 ...	8.9	96.8
R.D.S. 8/4 ...	20.6	95.5
R.M.S. 1/1 ...	21.2	87.9

The selfed seed of all free resistant plants was bulked and will sow a feddan in isolation at Abdel Magid in the coming season.

The importance of this work lies in the fact that, in the past, leaf-curl disease has periodically taken a very heavy toll of the Gezira crop. Should field sanitation during the close season ever be relaxed, there is every likelihood of this disease again decimating the crop. Its attack is mainly confined to Domains Sakel since X.1730A shows high resistance under Gezira conditions. At Shambat, for some unknown reason, X.1730A is more susceptible than Domains Sakel. This season, at Gezira Research Farm, the writer observed infected plants of X.1730A in Plot 231 and selfed seed of these will be investigated next season.

It would appear that leaf-curl resistance can be built up in Sakel by continuous simple selection.

Miscellaneous.

Progeny row selections of BAR.898 ; BAR.396 (=BAR.898 × NT.2) and Red BAR.1730 strains were also grown for observation and analysis.

A small bulk of a completely fuzzy-seeded X.1730A was also grown. This bred true for complete fuzz.

Seven hundred flowers each of Domains Sakel and of X.1730A, grown under the same conditions, were tagged at fortnightly intervals from the beginning to the end of flowering. Twenty-five bolls of each tagging were picked when 20 days old, and subsequently at 5 day intervals until maturity, and sent separately to the Shirley Institute for examination of lint development and fineness. A mature sample of lint of each tagging was also sent for hair and spinning tests. The Shirley Institute hopes, from this work, to obtain more information on how lint quality is built up.

Defoliation Experiment.

This experiment was designed to test the effect of cyanamid as a defoliant with a view to its possible use in facilitating picking.

Two trials, each of five replications, were made. In the first, cyanamid was applied by atomic duster at the rate of 34 lb. per acre, the controls being left undusted. In the second trial the cotton plants were sprayed with water before dusting. Little destruction of the leaves was obtained with either trial.

VARIETY TRIALS.

In the 1946-47 season, three cotton variety trials were carried out in the Gezira—at Kab el Gidad (North), Gezira Research Farm (Centre) and Hag Abdulla (South). The layout was in each case a randomized block with 10 replicates and as far as possible the preparation, cultural operations and irrigation were identical with those practised by the normal Sudan Plantations Syndicate tenant. No manuring was done and the cotton followed two years of fallow at Kab el Gidad and Gezira Research Farm and one year of fallow at Hag Abdulla.

The season was a good one, and germination and early growth were excellent. An early and severe attack of jassids in the Northern Group of the Sudan Plantations Syndicate reduced yields at Kab el Gidad considerably, and leaf-curl disease was also much in evidence. At Gezira Research Farm an attack of flea beetle in Block 1 of the trial caused some damage but was quickly controlled by Gammexane dusting. An early localized blackarm attack caused severe shedding of the lower leaves and sympodia in a few sub-plots, particularly in the Domains Sakel control plots. Domains Sakel Selection 2, both at Gezira Research Farm and Hag Abdulla, was attacked much later, but at maturity both this and Selection 1 differed little from the parent control.

In general the plots could be said to be representative of their respective areas, though the Kab el Gidad site was very low-lying and suffered from waterlogging. The sites at Gezira Research Farm and Hag Abdulla were very weedy in the early stages because of continuous rains coupled with shortage of labour.

Nine varieties were tested at each site:—(1) General Domains Sakel Control; (2) Domains Sakel Selection 1; (3) Domains Sakel Selection 2; (4) X.1730A ex Gash (Control); (5) X.1730A ex Tokar; (6) BAR.1730L; (7) BAR.1730L—Selection 1; (8) BAR.4/5; (9) BAR.4/II.

The trials were designed to provide information on the following points:—

- Are the Domains Sakel Selections 1 and 2 at least up to the parent Domains Sakel bulk in yield? If so, they can be recommended for propagation on account of their uniformity in quality.
- Does Tokar grown seed of X.1730A give as good a crop as Gash grown seed when sown in the Gezira? If so, seed supply problems could be eased by the use of Tokar seed to supplement or even to replace that produced in the Gash.
- Are BAR.1730L, BAR.1730L Selection 1, BAR.4/5, and BAR.4/II (X1730 strains to which genes for blackarm resistance have been transferred) at least equal in yield to X.1730A, when blackarm is well under control?
- Information is also provided on the relative yields of Domains Sakel and X.1730 types, and on the interaction between locality and variety.

YIELD DATA ARE SUMMARISED IN TABLES I—III BELOW:

TABLE I.
YIELDS OF SEED COTTON IN POUNDS PER ACRE.

Variety	Yield			
	Kab el Gidad	Gezira Research Farm	Hag Abdulla	Mean
X.1730A ex Gash	1,063	2,035	2,095	1,731
X.1730A ex Tokar	1,124	2,007	2,008	1,713
BAR.1730L Selection 1	1,044	1,918	2,059	1,674
BAR.4/5	980	1,959	2,073	1,671
BAR.1730L	997	1,892	2,077	1,655
BAR.4/II	1,019	1,893	2,032	1,648
Domains Sakel Selection 2	844	1,662	1,944	1,480
Domains Sakel Selection 1	954	1,659	1,722	1,445
Domains Sakel	913	1,499	1,688	1,367

TABLE II.
YIELD OF LINT IN POUNDS PER ACRE.

Variety	Yield			
	Kab el Gidad	Gezira Research Farm	Hag Abdulla	Mean
X.1730A ex Gash	355	725	749	610
X.1730A ex Tokar	381	704	731	605
BAR.1730L	344	695	765	601
BAR.1730L Selection 1	355	660	743	586
BAR.4/II	331	646	697	558
BAR.4/5	319	650	697	555
Domains Sakel Selection 1	295	559	580	478
Domains Sakel Selection 2	251	536	640	476
Domains Sakel	284	473	581	446

TABLE III.
GINNING OUTTURN (PERCENTAGE).

Variety	Ginning Outturn			
	Kab el Gidad	Gezira Research Farm	Hag Abdulla	Mean
BAR.1730L	34.6	36.7	36.8	36.0
X.1730A ex Tokar	33.9	35.1	36.4	35.1
X.1730A ex Gash	33.3	35.7	35.7	34.9
BAR.1730L Selection 1	34.0	34.4	36.1	34.8
BAR.4/11	32.5	34.1	34.4	33.7
BAR.4/5	32.5	33.1	33.6	33.1
Domains Sakel Selection 1	31.0	33.7	33.7	32.8
Domains Sakel	31.2	31.6	34.4	32.4
Domains Sakel Selection 2	29.7	32.2	32.9	31.6

Significant differences were obtained in all three trials.

The BAR.1730 strains, where attacked by blackarm, were obviously more resistant than X.1730A ex Gash and ex Tokar and did not shed their lower leaves and sympodia as rapidly or in such quantities. Observations at Hag Abdulla showed that blackarm had caused severe shedding of lower leaves and sympodia in a few sub-plots in the trial and in the adjacent commercial crop of X.1730A. The first retained bolls were generally found at node 23 instead of at nodes 12-15. Blackarm counts were made, and gave the following percentages of holes infected :—

Site	Date	X.1730A		BAR. 1730L	BAR. 1730L/1	BAR. 4/11	BAR. 4/5	Domains Sakel		
		Gash	Tokar					Sel. 1	Sel. 2	Control
Kab ...	21/9/46	0.1	1.0	—	—	—	—	0.1	0.6	2.2
G.R.F. ...	9/10/46	1.0	3.2	—	—	—	—	1.1	1.2	10.2
Hag. Abd.	3/10/46	26.2	19.0	0.2	0.1	—	0.5	38.1	100.0	100.0

At Kab el Gidad and Gezira Research Farm, leaf-curl attacked the Domains Sakel control and selections quite severely but never appeared on the X.1730 strains. Luckily the attack was fairly late in the season.

Other pests and diseases were negligible.

Taking the four questions in order, it is evident that under the conditions of the trials, the Domains Sakel Selections 1 and 2 were not inferior to Domains Sakel control. Overall, the differences in both seed cotton and lint yields were slightly in favour of the selections, and at the Gezira Research Farm the differences were significant.

Differences between X.1730A from Gash and from Tokar seed were quite small and insignificant throughout, and so far as these trials go, Tokar can be recommended with confidence as a source of planting seed.

The data support Knight's conclusion (see Shambat report) that BAR.1730L gives as good a lint yield as X.1730A. There were no significant differences in seed cotton yield between X.1730 strains and their derivatives. In lint yield, however, the three derivative strains BAR.1730L Sel. 1, BAR.4/11, and BAR.4/5 were somewhat below the Gash and Tokar controls, the difference being significant in the Gezira Research Farm trial. On these results, BAR.1730L is to be preferred among the blackarm resistant strains. Gezira grown seed was used to

sow the BAR.4/11 plots, and it is known that this gives rather lower yields than Gash seed. Judgment must therefore be reserved on the comparison of BAR.4/11 (which is B₂ B₃) with BAR.1730L (the best of the B₂ strains).

A comparison of the behaviour of Domains Sakel and X.1730 strains in the three localities may be made by setting out the mean yields of the three Domains Sakel strains against those of Gash and Tokar X.1730A and BAR.1730L These are given in Tables IV and V below.

TABLE IV.
MEAN SEED COTTON YIELDS OF X.1730 AND DOMAINS SAKEL STRAINS.

Variety	Kab el Gidad	Gezira Research Farm	Hag Abdulla	Mean
X.1730	1,056	2,000	2,059	1,705
Domains Sakel	904	1,607	1,785	1,432
Percentage increase of X.1730 over Domains Sakel	17	24	15	19

TABLE V.
MEAN LINT YIELDS OF X.1730 STRAINS AND DOMAINS SAKEL STRAINS.

Variety	Kab el Gidad	Gezira Research Farm	Hag Abdulla	Mean
X.1730	360	708	748	605
Domains Sakel	277	523	600	467
Percentage increase of X.1730 over Domains Sakel	30	35	25	30

Yields increased from north to south, but there was no evidence of a consistent trend in the relation between Domains Sakel and X.1730. On seed cotton, a premium of about 20 per cent. was required in this season to make Domains Sakel as remunerative as X.1730.

Owing to the lower ginning outturn of Domains Sakel, a premium of 25-30 per cent. in lint prices would be required to make Domains Sakel equally remunerative.

GRADING.

The Manager, Sudan Plantations Syndicate, kindly allowed Mr. Kimon, the Head Classifier, to grade the sub-plot samples of the Gezira Research Farm trial. All pickings gave particularly low grades, averaging nearly grade 5 over the first four pickings.

Throughout the Sudan Plantations Syndicate area grades were also very poor. It is difficult to pin down the cause of the general low grade crop, but this season this Section collaborated with the Shirley Institute in experiments to try to determine the answer. Seed cotton of both Sakel and X.1730A was (a) Picked normally and stored in the sun, (b) Picked normally and stored in shade, (c) Left on tree as late as possible and (d) Picked immediately the bolls opened. Samples of these were sent to the Shirley Institute for testing.

DISCUSSION AND SUMMARY.

Domains Sakel, D.S.1 and D.S.2.

In yield these strains did not differ significantly and, provided the slightly superior grade and quality of D.S.1 is upheld this season by

spinning tests and market reports, there seems no reason why D.S.1 should not replace the present commercial parent strain.

X.1730A ex Gash and ex Tokar.

These strains showed themselves to be identical in germination, growth and yield. Samples have been sent for testing. If the hair and spinning tests are identical, it is suggested that Tokar should replace the Gash as the X.1730A seed area.

X.1730A (ex Gash) and the BAR.1730 series.

BAR.1730L is a satisfactory blackarm resistant substitute for X.1730A. Other blackarm resistant strains are not yet passed for distribution.

PROGRAMME OF WORK FOR 1947-1948 SEASON.

The work for next season will follow the same lines as it did this season. In addition, however, BAR. Domains Sakel will be available for observation, selection and filtering and a small bulk of it will be grown at Abdel Magid to obtain seed for variety trials.

SHAMBAT STATION.

BY

R. L. KNIGHT.

INTRODUCTION.

The basic work of the Shambat Station remains the direct application of genetics to plant breeding problems. The emphasis has been on disease and pest resistance—blackarm, jassids, Pink bollworm and Egyptian bollworm—and the line of attack has been to attempt to control the disease by utilizing major genes governing resistance. This has often meant employing interspecific gene transference as a standard plant breeding technique. So far, a number of interspecific gene transferences have been successfully carried out, resulting in types which are an improvement agriculturally, but which are unchanged in their spinning quality. This is the objective in all this work—to transfer a desirable gene to a commercial type leaving the variety unchanged except for the effect of the transferred gene. As these transferences reach completion, the resulting strains are sent out to the plant breeders at Medani and Kadugli for testing, and for “filtering” in their breeding plots when this seems desirable.

Thus there are two stages in this work :—(1) straight gene transference resulting in agricultural improvement but not affecting lint, and (2) filtering, which can improve both agricultural qualities and lint but which should only alter lint qualities within the accepted range

of the type. All types leaving Shambat are at stage 1; Mr. Evelyn's "filtered" selections within these types represent stage 2.

In August, 1946, the writer visited Kawanda for a month at the invitation of the Uganda Government. He welcomes this opportunity of expressing his appreciation and thanks to the various members of the Uganda Department of Agriculture and of the Empire Cotton Growing Corporation with whom he came in contact, for their generous hospitality and whole-hearted co-operation.

METEOROLOGY.

Rains again started in May, fully a month earlier than usual, and continued into October. The total rainfall for the year was 5.6 inches but, although this was well distributed throughout the early growing period of the crop, blackarm inoculations did not in general take as well as usual.

Except for an unpleasant period in October, temperatures were again low. In the period 1st May, 1946, to 30th April, 1947, inclusive, there were only 197 days when the shade temperature registered 100°F or over, 25 days with 110°F or more, and no days with a temperature of 115°F or over. These figures compare with 206, 38 and 4 days respectively, representing the average for the previous four seasons. These lower temperatures resulted in a very successful out-of-season crop.

Except for the loss of a few mud buildings near the irrigation pump no damage was done to the Research Farm by the record high Nile experienced this season, and although the river level rose well above the level of the centre of the Farm it did not break in.

GENETICS AND BREEDING.

Production of Blackarm Resistant "Egyptian" Varieties.

1. *Blackarm Resistant Domains Sakel*.—The transference, from blackarm-resistant NT.2, of the *hirsutum* resistance genes B_1 , B_2 and B_3 to Evelyn's Selected Domains Sakel (D.S.1) was carried to the sixth backcross stage. F_2 progenies of sixth backcross type were grown out of season and, from these, seed was obtained for sowing small propagation plots next season of B_1B_1 Domains Sakel, B_2B_2 Domains Sakel and B_3B_3 Domains Sakel. It should be noted that although these three types are of sixth backcross origin, as regards Domains Sakel parentage, the B_1B_1 and B_2B_2 types represent sixteenth backcrosses to *barbadense* from *hirsutum*, whilst the B_3B_3 type is a fourteenth backcross.

Plants carrying B_1 , B_2 and B_3 in these sixth backcross F_2 's were crossed with Evelyn's latest leaf-curl resistant Domains Sakel with a view to combining resistance to both diseases by backcross-crossing to the leaf-curl resistant stock. The reason for backcrossing to the leaf-curl resistant parent is that, whereas blackarm resistance is controlled by major genes, Evelyn's work shows that leaf-curl resistance

is almost certainly dependent on a number of minor genes. By careful selection he has bred a type which is virtually immune. If the attempt to combine blackarm resistance with leaf-curl resistance were limited to straight hybridization it is almost certain that a number of these minor genes would be lost. By backcrossing to the leaf-curl resistant parent it is possible to ensure that the whole of the leaf-curl resistance gene-complex remains unchanged.

In addition, a small propagation area of fourth backcross material homozygous for B_2 was grown and yielded 112 lb. of seed for propagation and testing next season.

In the transference of blackarm resistance from *G. sanguineum* (= *G. arboreum* race *bengalense*, Silow) to Domains Sakel the gene B_4 was successfully carried to the eighth backcross to *barbadense* (fourth backcross to Domains Sakel) and ninth backcross seed was produced for sowing next season. B_4 segregates independently of B_1 , B_2 and B_3 , and it shows additive effect in conjunction with B_2 and B_3 . The transference of this Asiatic gene to Sakel has been written up as Part VI of the Genetics of Blackarm Resistance.

In a second transference from *sanguineum* to Sakel an F_1 of tetraploid* *sanguineum* $\times$ Sakel, consisting of 89 plants, was grown. From this F_1 209 first Sakel backcross seeds have been obtained for sowing next season.

Two seasons ago it was noticed that the variety Grenadines White Pollen (one of the types in the Corporation's Type Collection) showed marked resistance to blackarm. Grenadines White Pollen is a perennial *barbadense*. Crosses with Domains Sakel and with X.1730A reached the first backcross stage this season and second backcross seed was produced for sowing next season. A single major gene appears to govern resistance but the relationship between this gene and the B_1 , B_2 , B_3 and B_4 genes is as yet unknown.

2. *Blackarm resistant X.1730*.—BAR.1730L, which carries B_2 , was derived from the seventh backcross of Uganda B.31 by varieties of the X.1530-X.1730 group (the last four backcrosses were all on to X.1730 strains and the first four crosses were all on to X.1530 strains). BAR.4/5 is similar to BAR.1730L except that it has had two more backcrosses to X.1730. type parents—it is of ninth backcross origin.

In testing the lint of BAR.1730L against X.1730A twelve comparisons, from four seasons' varietal tests, are now available.

Averages from the Shirley Institute's spinning tests are given below :—

	BAR.1730L	X.1730A
Effective length (32nds)	47.8	48.3
Standard hair wt.	156.3	159.0
Corrected strength product, 80's	2,293	2,284
Corrected strength product, 100's	1,980	1,971

*Throughout this report, statements on ploidy are based on inference only. The appointment of a cytologist will make possible a proper check on conclusions drawn from morphological and genetic data.

Turning now to yield differences: twenty comparisons of BAR.1730L with X.1730A, spread over a period of five years, are available. In these tests BAR.1730L has averaged 552.8 lb. of lint per acre as against 552.9 lb. for X.1730A, under conditions in which every effort has been made to exclude blackarm.

The relative merits of these two strains were discussed in detail in my last season's report and it has now been decided to conduct, next season, a commercial trial of BAR.1730L and X.1730A in which the former will be sown a fortnight earlier than the latter. As pointed out in my last report, the earlier sowing (made possible by the presence of blackarm resistance) would allow a longer growing and fruiting period and would also, it is considered, improve grade. Incidentally a greater range in permissible sowing date would improve the labour situation in the Gezira.

Last season's spinning tests for BAR.4/5 versus X.1730A are now to hand so that, with 1944-45 results, six comparisons are now available. Averages of these are given below:—

	BAR.4/5	X.1730A
Effective length (32nds)	48.2	48.3
Standard hair wt.	154.7	160.0
Corrected strength product, 80's	2,291	2,273
Corrected strength product, 100's	1,965	1,926

BAR.4/11 is a very resistant X.1730 type carrying both B_2 and B_3 . Spinning tests are now available for three tests of this versus X.1730A. The averages of these figures, given below, show BAR.4/11 to be fully the equal of X.1730A in spinning quality.

	BAR.4/11	X.1730A
Effective length (32nds)	48.0	46.7
Standard hair wt.	154.7	157.7
Corrected strength product, 80's	2,239	2,215
Corrected strength product, 100's	1,908	1,908

3. *Flagging Blackarm-resistant X.1730 with the arboreum gene for red flowers and leaves.*—This is being carried on as a routine process. The end product will eventually be tested against the end product of the straight blackarm-resistant X.1730 breeding programme.

Production of blackarm-resistant strains of American Upland for the Southern Sudan.

1. *Blackarm-resistant Uganda SP.84.*—This season a small propagation plot of BAR.SP.84 homozygous for both B_2 and B_3 was grown. The B_3 gene was originally obtained from *G. hirsutum* var. *punctatum* and it was transferred to BAR.SP.84 by backcrossing. The new type has been given the number BAR.7/7.

2. *Blackarm-resistant Uganda BP.52.*—Ninety pounds of seed of BP.52 type homozygous for B_2 were produced from a small isolated propagation plot of fifth backcross derivation. Some of this seed was sent to Kawanda, Uganda, for trial, and the type will also be included in the Equatoria varietal tests next season under the number BAR.12/3.

3. *Blackarm resistance in Indian Upland cottons*.—Six types from India were grown this season. Of these, Victory, 199F, L.S.S. and 216F were all heterogeneous for resistance whereas 244F and 268F were homogeneous for resistance (presumably due to B_2).

Bollworm Resistance.

At Shambat, only Pink bollworm (*Platyedra gossypiella*) and Egyptian bollworm (*Earias insulana*) occur to any appreciable extent. As previously recorded, *G. armourianum* and *G. thurberi* show marked resistance to both bollworms, but until this season an adequate sample of bolls had not been available to obtain a preliminary examination of the resistance possibilities of the other wild species. This season a complete year's crop was sampled and the following figures were obtained :

Species.	No. of bolls examined	Average % B/W	% Pink B/W	% Egyptian B/W	Range in total B/W infection during season.
<i>G. anomalum</i> WB1-1 ...	1,000	23.2	2.8	20.4	11—39%
<i>G. stocksii</i> WE1-2 ...	1,000	9.7	4.2	5.5	3—16%
<i>G. somalense</i> WE2-2 ...	1,000	2.8	1.7	1.1	0—9%
<i>G. thurberi</i> WD1-2 ...	1,000	1.6	1.2	0.4	0—4%
<i>G. armourianum</i> WD6-2 ...	878	1.1	0.4	0.7	0—3%
<i>G. klotzschianum</i> WD7-1 ...	100	10.0	3.0	7.0	—
<i>G. klotzschianum</i> var <i>davidsonii</i> WD8-2 ...	1,200	14.7	7.6	7.1	10—23%
<i>G. raimondii</i> WD9-1 and 2	344	35.2	29.4	5.8	22—46%

NOTES.

1. Where a boll showed attack by both Pink bollworm and Egyptian bollworm it was listed as Egyptian.
2. The figures for *G. klotzschianum* were supplied by Mr. Hutchinson; *G. klotzschianum* var *davidsonii*, examined at the same time, also showed a 10 per cent. attack.
3. The classification into Egyptian and Pink was made by Lloyd Eff. George of the Entomological Section and it was based on the nature of the damage, since the examination was confined to open bolls.

The interesting features of these results are :—

- (a) *G. thurberi*, *G. armourianum* and *G. somalense* all show marked resistance to both types of bollworm. In this connexion it is of decided interest that the first two have woody bolls whereas *G. somalense* has bolls of paper thinness.
- (b) *G. anomalum* appears to be resistant to Pink but susceptible to Egyptian bollworm whereas *G. raimondii* appears to be resistant to Egyptian but susceptible to Pink bollworm. The resistance of *raimondii* to Pink bollworm may be fictitious, since the plants of this species were not flowering freely throughout the season.

1. *Gossypium thurberi* crosses.—The objective is the transference, to Sakel and American Upland types, of resistance to Pink and Egyptian bollworm. The first step was the synthesis of the hexaploid *G. "thurbadense"* (= *thurberi* × Domains Sakel, doubled with colchicine). This season a progeny of 65 plants of second backcross type was grown. The parentage of these plants was

$$G. "thurbadense" \times \text{Domains Sakel}^2 F_1.$$

In this progeny 32 of the plants were sterile or almost completely sterile, 21 showed good fertility and the rest were reasonably fertile. Bollworm damage varied greatly from plant to plant and a number of selections were made for further backcrossing to Domains Sakel.

These progenies will be sown next year on an extensive basis interspersed with alternate rows of controls, and the whole area will be deliberately subjected to a heavy bollworm attack.

On the American side a presumed pentaploid progeny of *G. "thurbadense"* $\times$ Domains Sakel F_1 composition was bulk crossed with XA.129. Some 900 seeds were produced from this cross for sowing against XA.129 controls next season. XA.129 was chosen as the parent for the initial stages of this crossing programme because it appears to be unusually susceptible to bollworm attack.

2. *G. armourianum* crosses.—Here again the objective is the transference, to Sakel and American Upland types, of Pink and Egyptian bollworm resistance. The hexaploid *G. "armadense,"* which was the first step in those transferences, arose in 1943 spontaneously from a damaged branch on a sterile F_1 plant of *G. armourianum* $\times$ Sakel F_1 composition. Five more plants of *G. "armadense"* were subsequently obtained by wiring sympodia on F_1 triploid plants—it was found that such wired branches occasionally produced a boll with one, or rarely two, seeds, and the seedlings which were subsequently raised from these proved to be typical "*armadense*."

This season only a small second backcross progeny, consisting of fifteen plants, was grown. The parentage of these plants was

G. "armadense" $\times$ Domains Sakel² F_1 .

It is noteworthy that even in this small progeny two very fertile and three reasonably fertile plants appeared. These five plants have all been backcrossed to Sakel. In addition, seed has been produced to enable a large second backcross progeny to be grown next season interspersed with controls and adequately infested with bollworm.

On the American side, *G. "armadense"* was crossed with XA.129 and the pentaploid F_1 plants were bulk backcrossed to XA.129, out-of-season. A large backcross progeny will be grown from this next season under conditions of heavy bollworm infestation and adequately interspersed with controls.

Jassid Resistance.

As noted in my last Report, the objective in this work is to transfer to Sakel major genes for hairiness from a range of types, and then to test their efficacy in various combinations. The economic background of these transferences is the fact that spraying with insecticides has demonstrated that yield, in the Northern Gezira, can be increased by a third of a kantar to one kantar (312 lb.) of seed cotton per acre by the partial elimination of insects, mainly jassids.

This season it was shown that the main *Carpulla* gene occupies the same locus as H_1 , the Tanguis gene. Now that both are on a Domains Sakel background it will be possible to determine, next season, whether they are identical genes or alleles of each other.

In the transferences from the other types, MU.8b and Ferguson are very promising as sources of hairiness. Both types have a major

gene governing hairiness (plus a complex of minor genes) but, as appears to be usual, these main genes do not give length to the hairs. However, the length modification in both MU.8b and Ferguson appears to be inherited on a fairly simple basis, so that there is considerable hope of being able to transfer reasonable hair density and length to Sakel.

Other Investigations.

1. *Deciduous bractlet*.—Both in transferences within the American Upland group and from this to Sakel, this character is inherited as a recessive. This season, F_2 s were grown of "Deciduous Bractlet" $\times$ BAR.SP.84 and "Deciduous Bractlet" $\times$ Sakel. Unfortunately all the evidence suggests that this character, in addition to causing abnormal leaves*, also causes boll shedding and possibly reduces boll size.

2. "Cluster" characters.—The transference of "Egyptian Short Branch" to Domains Sakel was taken to the first backcross F_2 stage and second backcross seed was produced for sowing next season. The transference of the Upland character "Cluster" to Domains Sakel reached a similar stage.

3. *The genetic nature of the blackarm immunity of G. anomalum*. *G. anomalum* (nearly immune) was crossed with a fully susceptible *arboreum* type from Java and backcrossed to the Java parent. The resistance of *anomalum* is recessive, but it was hoped that a sufficient number of plants in this first backcross would show enough fertility to make it possible to recover the resistance in F_2 . Unfortunately the fertility of this first backcross was very low and, out of 51 plants, only 5 produced seed.

4. *G. somalense* crosses.—*G. somalense* (σ) was successfully crossed with an *arboreum* (φ) from Java, but the F_1 plants were very weak and even six months from sowing only ranged from 2 to 4 inches in height. In slowness of growth and weakness the plants resemble the F_1 of *anomalum* $\varphi \times$ *somalense* σ .

Wild Gossypium Accessions.

During the season Mr. Andrew, Government Geologist, and George Yanni Karkanis, Geologist, very kindly helped in the search for wild *Gossypium* species. They sent in bolls of *G. anomalum* from the following localities :—

$\frac{1}{2}$ mile N.E. of Hamra $12^\circ 51' N.$, $28^\circ 48' E.$

Jebel Tuyus $14^\circ 20' N.$, $31^\circ 33' E.$

Jebel Katul $14^\circ 13\frac{1}{2}' N.$, $29^\circ 21' E.$

All three accessions showed evidence of bollworm damage which, from its nature, was probably caused by Sudan bollworm.

*Stephens, S. G. 1947. Emp. Cott. Gr. Rev. 14.1. 28-35.

Messrs. Andrew and Karkanis also found several new *G. somalense* sites from which they sent in seed. These sites were located as follows :

Jebel Katul 14° 14' N., 29° 23' E.

Jebel Abu 'Asal 14° 15' N., 29° 13' E.

In addition Mr. Hutchinson and the writer found *G. somalense* growing on Jebel Ibrahim Kabbashi (15° 48' N., 32° 50' E.).

Polyploids.

G. "davidense." The writer has grown large numbers of F_1 seedlings of *G. davidsonii* ♂ × Sakel ♀ but all have died in the cotyledon stage. It was, however, thought that perhaps the hexaploid might be viable; accordingly two seeds of *davidsonii* ♂ × Sakel ♀ composition were soaked in 0.05% colchicine for 48 hours. Both resulting seedlings survived the cotyledon stage and although one succumbed later to root damage, the other is now a flourishing, though so far sterile, shrub.

In addition, tetraploid Wagad 8 (*G. herbaceum*) and Java (*arboreum*) were produced and crossed with Sakel as the start of two transference lines. The F_1 of tetraploid Wagad 8 × Sakel has been successfully backcrossed to Sakel and a number of first backcross seeds are available for sowing next season.

Tetraploid "Multani" (*G. arboreum*) was crossed with Domains Sakel and an F_1 consisting of 89 plants was grown. By continually pollinating these F_1 plants with Domains Sakel pollen, 209 seeds of first Sakel backcross type were obtained for sowing next season.

The cross *G. anomalum* ♂ × Domains Sakel ♀ is being treated with colchicine to produce the hexaploid *G. "anomadense."*

DISEASES AND PESTS.

Blackarm, *Xanthomonas malvacearum*, was, as usual, general during the rains.

Leaf-curl was light in the crop sown at normal time, but it increased in the out-of-season plots due to the accumulation of diseased material for use in a leaf-curl resistance trial next season.

Pink and Egyptian bollworms were controlled on breeding plot areas with Gammexane and D.D.T. sprays.

PUBLICATIONS.

- Knight, R. L. "Dictionary of Genetics." *Chronica Botanica Co.* "A New Series of Plant Science Books" c. \$4.00 (*in press*).
 Knight, R. L. The role of major genes in the evolution of economic characters. *J. Genet.* (*in press*).
 Knight, R. L. The genetics of blackarm resistance VI. Transference of resistance from *G. arboreum* to *G. barbadense*. *J. Genet.* (*in press*).

SUMMARY AND CONCLUSIONS.

In transferring blackarm-resistance to Evelyn's Selected Domains Sakel, seed was produced for sowing small propagation plots, next season, of B_1B_1 , B_2B_2 and B_3B_3 type. No further backcrossing will

be necessary and the B_2B_2 type will go forward to larger scale propagation and testing pending the integration of a type carrying all three genes as a final product.

Meanwhile crosses have been made between these blackarm-resistant strains of Evelyn's Sakel and his latest leaf-curl resistant Sakel. This is the first step towards combining blackarm resistance with leaf-curl resistance and it is estimated that only two seasons of crossing will be required to do this.

A new blackarm-resistance gene has been transferred to Sakel from *G. arboreum*. This gene, B_4 , segregates independently of the other known genes B_1 , B_2 and B_3 . In this connexion it is considered that the technique of doubling the Asiatic parent, then crossing it with Sakel and backcrossing to Sakel on a large scale is a useful plant breeding tool in making gene transferences from Asiatic types to Sakel.

Twelve spinning test comparisons, spread over four seasons, of BAR.1730L with X1730A show the former to be fully the equal of the latter, whilst six comparisons of BAR.4/5 with X1730A show this blackarm-resistant type to be superior both in standard hair weight and in strength. Similarly BAR.4/11 (which carries both B_2 and B_3) is shown to be superior to X.1730A in length, hair weight and strength.

On the American Upland side, a small propagation plot of BAR.SP.84 homozygous for both B_2 and B_3 was grown and 90 lb. of seed of fifth backcross Uganda BP.52 homozygous for B_2 was produced.

Examination of a season's crop in the plot of wild *Gossypium* showed *G. somalense*, *G. thurberi* and *G. armourianum* to be almost immune to both the Pink and Egyptian bollworms. Transferences of this resistance from *G. thurberi* and *G. armourianum* to New World cottons have reached the second backcross stage and appear very promising. In both these transferences hexaploid parents were used as the first step.

It was demonstrated that the main hairiness gene in Carpulla occupies the same locus as H_1 , the main Tanguis gene for hairiness. Genetical studies also show considerable hope of being able to transfer adequate hairiness, for jassid control, from either MU.8b or Ferguson to Sakel.

PROGRAMME OF EXPERIMENTS 1946-1947.

All the lines of work shown in this report will be continued, the main effort being concentrated on transference of bollworm resistance from *G. thurberi* and *G. armourianum* to New World cottons, and on obtaining jassid resistance by the transfer of hairiness genes to Sakel.

KADUGLI STATION

BY

M. F. ROSE.

INTRODUCTION.

In contrast to the 1945-46 season, the present season opened favourably. Rains broke in April and continued steadily until mid-June, when all important plantings on the Kamina Farm were effected. Excellent stands of all crops were obtained and the early promise of record yields was fulfilled. In spite of heavy rains in August (259 mms.), which caused some waterlogging on low-lying areas, the sequence was excellent and plant growth sustained no check. Tables 1 and 1A give relevant data for the present season (Kadugli) with rainfall records of Dilling, Talodi and Kologi. All figures were well above average, that of 927.3 millimetres for Dilling being the highest ever recorded.

TABLE 1. RAINFALL RECORDS (MMS.).

Period.	Feb.	March	April	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Total
Kadugli, 46	—	—	41.0	35.0	157.0	94.0	259.0	120.0	71.0	6.0	783.0
" 45	—	—	—	165.0	66.0	188.0	142.0	81.0	17.0	—	659.0
" 1910-45	1.6	1.0	14.0	78.0	124.0	153.0	154.0	138.0	81.0	6.0	751.0
Dilling, 46	—	—	—	6.0	160.0	320.0	185.0	138.0	118.0	—	927.0
Talodi, 46	—	—	38.0	64.0	206.0	145.0	153.0	110.0	220.0	—	936.0
Kologi, 46	—	—	19.0	53.0	271.0	151.0	209.0	88.0	108.0	—	899.0

TABLE 1A. TEMPERATURES (°F), 1946.

	Mean Max.	Range.	Mean Min.	Range.
Period Growth (June-Nov.)	89.4	102.6—74.7	70.7	93.6—56.7
Period Resting (Dec.-May)	97.0	108.5—80.3	68.5	82.4—55.8

COTTON : ECONOMIC ASPECTS.

The position of cotton as a cash crop *vis-à-vis* that of dura as a food and cash crop remained unchanged from the 1945-46 season. The native was acutely aware of the enhanced value of dura, and the fear of local food shortage was a further stimulus to increase his dura at the expense of his normal cotton acreage. Government policy was to replenish depleted stocks and with this object in view propaganda was biased in favour of dura : general policy remained unchanged and the present season witnessed a further reduction in the cotton acreage. Talodi area, issued with seed for an equivalent of 3,600 acres, returned an estimated acreage of 1,500. Kadugli, which last season planted 2,000 acres, grew only 260 acres of isolated special bulk seed for type maintenance.

Following the good season and the excellent return from all crops, the general dura position showed marked improvement. Black Market prices fell from 40 P.T. to 5 P.T. per keila of 28 lb. and from December the crop was decontrolled. An increase in the purchase price of cotton from 42 P.T. to 75 P.T. per kantar (100 lb.) was the

cause of much self-recrimination amongst cultivators and judging by the general clamour for cotton seed for season 1947-48 it would appear that cotton will once more come into its own in the Nuba Mountains.

COTTON : COMMERCIAL YIELDS.

In spite of the excellent growing season, yields have not been above average. Rains were good throughout and there was no question of risk in planting the crop early (mid-June). Most bulk plantings were effected in July and August with an estimated averaged return of 300-400 lb. of seed cotton per acre. In spite of advice and propaganda on the merits of early planting, the sustained effort of planting both *dura* and cotton at the same time seems beyond the power of the cultivator. In terms of yield per acre, time of planting is more important than strain under Nuba Mountains conditions.

COTTON : BREEDING PLOTS.

Sixty-three progeny rows of (a) BAR.NT.205 and thirteen of (b) Nyasaland were planted on June 16th on the Kamina Farm. Ideal conditions throughout made selection work easy and any lot below the mean in vigour and productivity was ruthlessly discarded.

- (a) BAR.NT.205 maintained its standard of excellence, all lots showing marked regularity. It would appear from laboratory analyses that this strain has become markedly homogeneous. Yielding capacity, seed cotton per plant, will be tested by appropriate methods* in the coming season and the figures obtained will allow of further discarding by families.
- (b) The Nyasaland lots, in their second year at Kadugli, showed marked variability both between and within progenies. From observation and laboratory analyses it would appear that they are still sorting themselves out. An attempt is being made to push up the G.O.T.—which showed the low figure of 31.6 per cent.—while at the same time retaining the valuable attributes of fibre length and strength and marked general hairiness of plant. One progeny row was of special interest. The flowering and bolling curve was steep and 80 per cent. of the crop was given in one picking: with its dwarf squat habit, such a type might well be developed for mechanical harvesting, which may be introduced into an extensive area such as Gedaref. It will be of interest to see how such a lot behaves under the conditions of the normal bad season when sporadic rain, badly distributed, is the rule.
- (c) Following the success of BAR.SP.84 in all variety trials (season 1945-46) from Equatoria to Kadugli, it was essential to bring this small drought-resistant type back into the breeding plot. An area of three acres was isolated on the

* Hutchinson Compact Family Block Arrangement.

Main Farm, and from this 504 primary selections were made. All plants were carefully noted for (i) height, (ii) habit, (iii) hairiness of leaf and stem (both length and density) (iv) node number (earliness), (v) fruiting and opening and (vi) blackarm grade. Regarding (vi) all 504 plants were sprayed with blackarm suspension twice daily on consecutive days' six weeks from planting. Table 2 shows the distribution of the various "grades," with mean "grade" at 3.6.

TABLE 2.

Grade	0	1	2	3	4	5	6	7	8	9	10	Total.
F.	—	14	102	219	45	66	17	6	27	3	5	504
%	—	2.8	20.2	43.5	8.9	13.1	3.4	1.2	5.4	0.6	0.9	100

F. = Frequency.

BAR.SP.84, originally rendered homozygous for B_2 by Dr. Knight at Shambat, has had a wide circulation as a commercial bulk before returning this year to Kadugli. Outcrossing to recessive types can well account for the 35 $B_2 B_2$ types found at the tail-end of the distribution.

Table 3 shows the frequency distribution for node number.

TABLE 3.

Node No.	5	6	7	8	Total.
Frequency	29	219	234	22	504

All 22 plants having a node number of 8 were discarded: all 29 plants having a node number of 5 were ear-marked for the breeding plot. None of the latter will appear in the 1947-48 nucleus which is to supersede the mixed commercial bulk of BAR.SP.84. From the present season's experience and figures it would appear that all single plants of node number 5 have a less robust scaffolding, less potentiality for yield and are much more delicate than those of higher numbers. In spite of the importance of early and still more early types, robustness and vigour to withstand the vagaries of the Kordofan climate are the main essentials to a successful commercial crop.

COTTON : VARIETAL TESTING.

One Main V.T. and one Miscellaneous V.T. were planted on the Kamina Farm on the 16th and 17th of June respectively. Perfect stands were obtained, and over the Main V.T. (1.3 acres) a final yield figure of 2,098 lb. of seed cotton per acre was returned (654 lb. lint).

The Miscellaneous V.T. (3 strains $\times$ 2 spacings) planted on Block 8 suffered from severe waterlogging in August (259 mms.) but in spite of the fact that flowering was much retarded during this period, the trial averaged 1,114 lb. of seed cotton per acre (359 lb. lint). Picking dates for both trials were from the 19th October to 23rd November. The spacing for the Main V.T. was constant at 90 cms. $\times$ 90 cms.; that for the Miscellaneous V.T. 90 $\times$ 90 cms. and 90 $\times$ 45 cms.

Tables 4 and 5 give relevant data for the two trials.

TABLE 4.
(MAIN V.T. KADUGLI.)

<i>Variety.</i>	<i>BAR.SP.84</i>	<i>BAR.NT.205/43</i>	<i>BAR.NT.96/40</i>	<i>P.S.S. (Control).</i>
Yield S.C. per acre (lb.)	2,029	2,100	2,148	2,115
Yield lint per acre (lb.)	662 (107)	657 (106)	674 (108)	621 (100)
Mean G.O.T.	32.6	31.3	31.4	29.4
SIGNIFICANCE : Results non-significant.				

TABLE 5.
MISC. V.T. KADUGLI (SPLIT-PLOT LAYOUT).

<i>Variety.</i>	<i>BAR.SP.84</i>	<i>NT.205/42</i>	<i>P.S.S. (Control).</i>
Yield S.C. per acre (lb.)	946	1,163	1,232
Yield lint per acre (lb.)	325 (88)	381 (103)	370 (100)
Mean G.O.T.	34.4	32.8	30.0
SIGNIFICANCE : 46 lb. lint per acre (5 per cent. level).			
Spacing 45 cms.	423 lb. lint per acre.		
" 90 "	295	"	
SIGNIFICANCE : Excess 1 per cent. level.			

The points of interest from the Miscellaneous V.T. are listed below :—

- In terms of lint per acre, the 45 cms. intra-row spacing (over all strains) showed an increase of 128 lb. over the wide spacing : this increase of 43 per cent. in favour of the close spacing was highly significant.
- BAR.SP.84 did not respond to the close spacing (45 cms.) as did the other varieties (interaction Var. $\times$ Sp. significant at 5 per cent. P.T.) : this lack of response can reasonably be ascribed to waterlogging limiting the final yield of this drought-resistant type.
- The differential response of pickings to spacing indicated that for the closer spacing a higher percentage of the crop appeared in the earlier pickings.

The practical implications from the data obtained may now be considered :—

- An increase of 43 per cent. in lint per acre is unlikely to be effected through varietal improvement or introduction in the Nuba Mountain area ; under the conditions of the present season a change in intra-row spacing has achieved such a result.
- A change in the intra-row spacing to 45 cms. would raise the percentage of higher grade cotton in so far as it would increase the earlier pickings at the expense of the late.
- It would increase the native cultivator's "effective" crop—in short a percentage of the fourth and fifth pickings which normally would be abandoned owing to lack of potable water in the plains would find their way into the earlier pickings and thus be accounted for.

All data, however, must be regarded in the light of a very good season ; they might well be reversed in the normally bad one.

Table 6 indicates that the closer spacing in the present season has had no effect on general seed characteristics.

TABLE 6.
(MEAN OF FIVE REPLICATES.)

		G.O.T.	Lint Index.	Seed Wt.	(Mean Max.)
BAR.SP.84 ...	45 cms.	35.2	5.0	9.1	35.9
BAR.SP.84 ...	90 cms.	35.2	5.0	9.2	34.3
P.S.S. ...	45 cms.	32.0	4.6	9.8	31.1
P.S.S. ...	90 cms.	32.2	4.6	9.7	31.2

Spinning test samples from the two spacings of BAR.SP.84 and P.S.S. (Control) have been prepared for the Shirley Institute.

The varietal trial at Talodi was planted on June 27th, with picking dates from 17th November to the 28th December. Spacing and layout was the same as for the Main V.T. Kadugli. Relevant data are shown in Table 7.

TABLE 7.
V.T. (TALODI).

Variety.	BAR.NT.205/43	BAR.SP.84	P.S.S. (Control).
Yield S.C. per acre (lb.) ...	894	840	1,097
Yield lint per acre (lb.) ...	303	287	336
	(90)	(85)	(100)
G.O.T. ...	33.9	34.2	30.7
SIGNIFICANCE : 26 lb. lint per acre (5 per cent. P.T.).			

COTTON : NUCLEUS PLOTS AND SPECIAL BULK AREAS.

One small nucleus area of 0.3 acres was planted to BAR.NT.205/45 on the main Farm. This was the first nucleus from the parental bulk BAR.NT.205/43. In the previous season a small scale sample had been sent to the Shirley Institute, the results from which proved disappointing. Although it gave an effective length of 38 (32nds. ins.), well above the parental bulk (35), and a standard hair weight of 173 against 187-191, this did not result in outstandingly strong yarn or good yarn appearance (Small Scale Test Report No. 109). Confirmatory evidence will be obtained this season from a large scale sample. Two more nuclei from different origins are on hand for planting in the coming season.

Regarding special bulks in isolated areas, BAR.NT.96/40 was represented at Berdab (100 acres), NT.58/43 at Hamra (100 acres) and BAR.NT.205/43 at Miri (60 acres).

COTTON: BLACKARM DEVELOPMENT.

In order to study the development of blackarm under Kadugli conditions, types of cotton of widely different powers of resistance were obtained from Dr. Knight at Shambat. These were (i) BAR.13/1 carrying genes B_2 and B_3 on a 511D background, (ii) SUS.7/2, the susceptible element bred from SP.84R carrying neither B_2 nor B_3 and (iii) the local resistant type BAR.SP.84 carrying B_2 . The varieties were laid down in a randomized block experiment of 5 replications, each plot containing 45 plants.

The trial was planted on the Main Farm on July 5th and was sprayed twice daily with blackarm suspension on the 16th and 17th of August. The disease was slow to develop and did not reach its peak until August 25th. Three days later counts were made and the blackarm "grade" assessed. Table 8 gives this assessment with final yield figures.

TABLE 8.

Strains.	Yield S.C. per acre (lb.).	Grade (Mean).
Sus.7/2 (B_3)	852	8.4
BAR.SP.84 (B_2)	975	2.9
BAR.13/1 ($B_2 + B_3$)	1,290	2.4

In terms of B_2 , Sus.7/2 and BAR.SP.84 are directly comparable, being sister strains. Although the difference between them of 123 lb. seed cotton just falls short of significance, it cannot be ignored in the light of the present season. Sus.7/2 failed to give a bottom crop, and, had conditions been similar to those of the past season when October returned a rainfall of 17 mms., a much lower yield must have been obtained.

Following the initial infection of Sus.7/2 (the plots could be picked out at a distance) and subsequent leaf-shed, the plants developed fresh growth and went through to give a late crop of 852 lb.; apart from a few sporadic cases, general blackarm infection was absent and did not appear again in the crop. If periods of hot sunny weather are requisite for the development and spread of the disease*, its non-reappearance after the initial infection can be explained on these grounds, for August-September was characterized by low heavy cloud and complete lack of sunshine.

Table 9 gives relevant data for temperatures (°F) and humidity for one month from the inception of the experiment.

TABLE 9.

Period.	R.H. %	Range.	Mean Max.	Range.	Mean Min.	Range.
16.8—31.8	85	92—72	85°	89—78°	70°	73—64°
1.9—16.9	84	91—74	89°	91—84°	69°	72—67°

* Knight, R. L., Emp. Journ. Expt. Agric. Vol. XIV, No. 56, Oct. 1946.

COTTON : PESTS AND DISEASES.

(i) *Flea-beetle* (*Podagrica puncticollis*).—This pest made its appearance in the early stages of growth but was successfully controlled by dusting with D.D.T.

(ii) *Leaf Roller* (*Sylepta derogata*).—*Sylepta* appeared at the end of August and caused some damage in the breeding plots and variety trials ; it was controlled by the hand-picking of affected leaves at weekly intervals.

(iii) *Bollworms*.—In terms of final yield the bollworms had little effect on the crop, if it was planted early. American bollworm appeared at the budding and flowering phase, but never exceeded an infection figure of 0.2 per cent. (green boll samples). Sudan bollworm appeared with American, and reached an infection figure of 6.0 per cent. in early October : from that date sampling figures fell sharply. Pink and Egyptian showed the usual trend, increasing sharply from the beginning of October to late November. In the case of the former pest, figures showed marked fluctuations between areas : on December 1st the late planted crop at Hamra showed an infection figure of 30 per cent. whilst at Miri and Berdab figures of 4.6 per cent and 5.0 per cent. respectively were returned : final green boll samples at Hamra showed an infection figure of 50 per cent.

(iv) *Stainers*.—Stainers made their first appearance in the Kamina Farm crop on 8th August. The first arrivals were *sp. supersticiosus*, later reinforced by *sp. fasciatus*. On October 12th population figures for adults per acre over the Kamina Farm were as follows : (i) *fasciatus* 4,320, (ii) *supersticiosus* 8,630. This marked increase over last season's peak must be regarded with concern. However, little staining or bad opening was observed in the early crop : that in the late pickings was not above normal.

FOOD CROPS.

Dura.—Twenty-six nucleus roguing plots of types covering the Dilling—Kadugli—Talodi sector were planted on June 16th. All types except two behaved well under the excellent conditions of season : Wad el Gussair showed marked weakness of straw, and Wad Aker Kadugli, a dwarf, small seeded type, gave poor germination and growth both at Dilling and Kadugli. These two types have subsequently been discarded.

One hundred and forty-four single plant selections were made (six from each of the remaining twenty-four lots) and half of these will be planted as single plants (for type maintenance) in the coming season. Photographic records of all important head types were made so that future selections may conform to a definite standard : full data on maturation period, seed weight, seed colour and type are available.

Nine and a half tons of grade A seed (rogued commercial bulk), covering all the recommendations made by Mr. Evelyn for the Kadugli area, were handed over to the Department of Agriculture for general distribution. Such foundation stock should be of great value to the native cultivator.

Cow-peas (*Vigna sinensis*).—A collection of types from the Nuba Mountains was made at the end of last season. All lots were very mixed and considerable roguing was necessary to obtain a standard seed type. Twenty special bulks were planted on July 5th, from which were taken thirteen primary selections. These selections will be developed along the following lines: (i) very early maturing, semi-upright types to come in with the early "Nagads" and help bridge the "scarcity gap" of mid-August—early September (maturation period 73 days); (ii) dual purpose, grain cum fodder types (maturation period 120 days); (iii) bulky, long period fodder types which could profitably be grown under irrigation (maturation period 160 days).

In early August, all plots were badly infested with whitefly, and some developed marked symptoms of an undetermined virus very similar to those of Cotton Leaf-Curl. All selected plants showed resistance, and these will be planted as late as possible in the coming season to meet the brunt of a peak bombardment.

Groundnuts.—Barberton (Upright) and Beladi Local (Runner) were planted in replicated observation plots with a view to studying the development of these two types on the black cracking clays of the Nuba Mountains. Barberton, approximately 10 days earlier than Local, was pulled in $3\frac{1}{2}$ months and against Local gave the following yield of undecorticated nuts:—

(i) Barberton	1732 lb. per acre.	Shelling %	76.7
(ii) Local	1344 " " "	" " "	75.0

The unsuitability of the runner type for the heavier soils was most apparent at "lifting" time when a large proportion of nuts was unrecovered; if groundnuts *must* be planted on the heavy clays, upright types are strongly recommended; such types "peg" down in a very restricted area immediately below the plant and lifting operations are facilitated, with minimum loss.

Miscellaneous.—Small areas of tomato (T.9 and T.10), short-term Hickory maize, bamia and egg-plant were grown for type maintenance and seed distribution.

SUMMARY.

1. The season opened with good early rains and all important plantings on the Kamina and Main Farms were made by mid-June. Distribution was good to the end of October, and no check was received by the growing crop; excellent yields in all sections were returned at the end of an ideal season.

2. The dura/cotton relationship is discussed ; the end of season trend in favour of cotton is noted.
3. Sixty-three progeny rows of BAR.NT.205 and thirteen of Nyasaland were analysed.
4. Five hundred and four primary selections from commercial BAR.SP.84 were made on the Main Farm : these were filtered for node number and blackarm resistance as well as for general characteristics.
5. Relevant data for Variety Trials are given : a record yield of 2,098 lb. seed cotton per acre (654 lb. lint) was returned from the Main V.T. (from an overall area of 1.3 acres). The merits of close intra-row spacing (45 cms.) have been demonstrated for the season under review.
6. The development of blackarm under Kadugli conditions on three distinct *hirsutum* genotypes has been followed.
7. Insect pests of cotton are listed : their effect on the early planted crop was slight.
8. Twenty-six nucleus rogue plots of dura covering all important types were planted. From these one hundred and forty-four single plants were taken for type maintenance.
9. Nine and one half tons of grade A dura seed (rogued commercial bulk) were handed over to the Department of Agriculture for general distribution.
10. Thirteen distinct cow-pea types to cover the range of agricultural requirements in Kordofan have been selected.
11. The relative merits of " Upright " versus " Runner " habit in groundnuts have been discussed in relation to soil type.

PROGRAMME FOR SEASON 1947-48.

COTTON—BREEDING PLOTS.

- (a) *BAR.SP.84*. Twenty-seven progeny rows of *BAR.SP.84* will be planted on the Kamina Farm for type improvement.
Thirty-four progeny rows of *BAR.SP.84* will be grown in isolation on the Main Farm. These thirty-four lots will form the new nucleus to replace the commercial bulk. All lots will be sprayed with blackarm suspension and "splitters" uprooted. This will be the last phase in rendering the nucleus and breeding plot homozygous for B_2 .
- (b) *Nyasaland types*. Five progeny rows. An attempt will be made to raise the G.O.T. without loss of other valuable attributes.
- (c) *BAR.NT.205*. Compact Family Block Layout. Three families $\times$ five progenies $\times$ nine replications. To detect small differences in yield and measurable seed characters in this group which is now very homogeneous.

COTTON—VARIETAL TESTING.

Main V.T. Kadugli. Five strains $\times$ two spacings $\times$ five replications. BAR.SP.84, BAR.NT.205/45, BAR.NT.205/43, BAR.NT.96/40 and Pump Scheme Strains.

COTTON—MISCELLANEOUS.

“ Old ” versus “ new ” seed. To study the rate of degeneration of cotton seed (stored under ginnery conditions) in the Nuba Mountains. Six treatments $\times$ 6 replications: treatments BAR.SP.84/44/45/46 and NT.205/44/45/46.

Strains will be tested for (i) germination, (ii) relative growth rates, (iii) final yields.

COTTON—COMMERCIAL BULKING.

- (a) *BAR.SP.84.* 2,000 acres will be grown at Kologi; a further 2,000 acres at Abu Gubeiha. Seed for seventy-five acres will be issued to a panel of accredited cultivators on the Abu Habi Scheme.
- (b) *BAR.NT.96/40.* 1,200 acres will be grown in the Lagowa area.
- (c) *Pump Scheme Strain.* 4,500 acres will be grown in the Talodi area. 4,500 acres at Kadugli.

DURA.

Twenty-four nucleus rogue plots of all popular types will be maintained at Kadugli; bulk plantings of Fanda, Tahas' 85, and Imsak Maratak (earliest). Birgalli Ahmar, Karinaka (mid-season) and Kulum (late) will find their place in the general rotation. This bulk seed is to be available for general distribution.

GROUNDNUTS.

Varietal Testing. Six strains $\times$ six replications. Barberton, Abu Arba, Beledi Local, American Upright, Beledi Erect (ex Medani) Beledi Runner (ex Medani).

COW-PEAS.

Thirteen distinct types covering the range of requirements for Kordofan will be planted as small special bulks.

SIMSIM.

One and a half acres each of white and red seeded strains will be planted on the Main Farm, Kadugli in an endeavour to develop types which are (i) non-shattering, (ii) resistant to the local disease Marad Ed Dam.

MISCELLANEOUS OBSERVATION PLOTS.

- (a) *Sunflowers*:—(1) St. 3 (ex. S. Africa).
(2) EGR/312 (ex Medani).
(3) EGR/314 (ex Medani).
- (b) *Tepary Bean* (*Phaseolus acutifolius*).
- (c) *Soya Bean*:—(1) Non-shattering yellow I (ex S. Africa).
(2) EGR/279 (ex Medani).
(3) EGR/85 (ex Medani).
-

COTTON PROPAGATION.

Mr. J. Steven, the Inspector, Plant Propagation, took over his duties as from 1st August, 1946, after the start of the cropping season. The post came into being for the first time in the Sudan, and some time will be required for building up an organization for the distribution of seed of improved varieties of economic crops.

EGYPTIAN COTTON.

The propagation of Evelyn's Selected Domains Sakel took place in the Gash Delta on a well isolated area one mile from the nearest main crop cotton. A total of 733 feddans was sown early in September, 1946, and the seed from this crop will be used to sow an area of some 5,000 feddans on the Kassala Cotton Company's land.

Twenty feddans of BAR.4/5 were also sown in the Gash Delta. Seed from this crop will be used in the coming season by the Sudan Plantations Syndicate Ltd., to compare its blackarm resistance, yield and grade with those of X.1730A. For this purpose it is proposed to sow the BAR.4/5 two weeks ahead of the main crop X.1730A.

AMERICAN COTTON.

In order to multiply the seed of the promising new selection BAR. S.P.84, an area of 500 feddans was sown on the Abu Habi Scheme at Semeith. It is hoped that an area of 4,000 to 5,000 feddans will be sown in the coming season in the Nuba Mountains Province.

[Included by courtesy of the Uganda Government.]

UGANDA.

COTTON EXPERIMENT STATIONS, KAWANDA AND SERERE, PROGRESS REPORTS FOR THE SEASON 1946-47.

BY

H. L. MANNING

E. C. G. C. and Acting Senior Botanist.

KAWANDA AREA

INTRODUCTION AND SUMMARY.

During the absence, on long leave, of the Senior Botanist, the cotton breeding work and the food crops investigations were carried out by the writer. The greater part of the work was conducted at the Agricultural Research Station, Kawanda. It is emphasized, therefore, that any immediate conclusions apply to the surrounding area only, unless otherwise stated.

During the season, breeding work was directed towards the transference of resistance to blackarm and *Verticillium* wilt, from resistant varieties to high quality BP. 52. In addition, transference of tufted seed to BP. 52, with a view to reducing ginning costs, was continued.

A comprehensive seed survey was conducted for 102 ginnery areas, representing over a million acres. Lint samples, derived from the field, were analysed by the Shirley Institute. While hair characters showed that there was considerable variation, there was evidence, confirming that inferred from the reduction of the data in the laboratory here, that seed now grown in a fairly large area is likely to produce lint of the high quality expected of BP. 52.

Evidence was adduced to show that early planted cotton led to the highest lint yields. Additional evidence from independent trials over a number of years showed that planting dates up to the end of June have also been successful. Since much of the crop loss from very late planted cotton appears to result from adverse climatic effects at flowering and fruiting, it is suggested that less crop risk is involved where cotton is established before the cool dry season and the often unreliable "late" rains.

District Variety Trials conducted over a number of years have revealed an important interaction between variety and locality. Certain varieties, which yield well at high fertility levels, yield poorly at low levels of fertility. This information is likely to be of value in formulating future breeding policy.

Factorial fertilizer trials were conducted with cotton, *Eleusine* and groundnuts. Others, with maize, are not yet completed. Results so far obtained show that caution must be exercised regarding the application of Kenya silicophosphate. There is some evidence that large applications of silicophosphate cause a depressing effect, a part of which may be due to its adverse influence on germination. No such effect has been recorded for locally produced rock-phosphate. Yield increments resulting from added inorganic nitrogen were encouraging in all trials in the Eastern Province. For Buganda, where the land was of higher inherent fertility, it would appear that no large responses may be expected from land in the first or second year of cultivation after a three-year grass ley. There appears to be no obvious deficiency of potash. The effect of potash in combination with nitrogen showed some relationship with insect attack and appears to be worth further investigation.

METEOROLOGY.

Less rain than normal fell in the early part of the year. This had the effect of delaying the planting of food crops, and in consequence cotton planting throughout the Protectorate was generally late. The rainfall following the planting of food crops, though less in total than expected, was so well distributed that food crop yields at this station were of a high order.

For the delayed cotton planting rainfall was poorly distributed, and, in addition, cool cloudy weather appeared to inhibit the development of the plants. The effect of the climate was most marked at the time of spraying for *Xanthomonas malvacearum*. Following a protracted fruiting period, unseasonably heavy rains at maturity from January to March, 1947, resulted in quite considerable crop losses, the greater part of which were due to boll rot. Yields were much below average.

During the course of the season it became increasingly clear that the adverse effect of the climatic regime on the development of the cotton plant was more marked than would be expected from a cursory examination of the rainfall and temperature normals. It is customary to plant cotton after the beginning of May. From the meteorological summary below (Table 1) it will be observed that during the months June to August the average temperatures and mean daily hours of sunshine are rather lower than are experienced in many cotton growing countries for the period after planting.

TABLE I.

SUMMARY OF METEOROLOGICAL DATA—KAWANDA

Month.	Rainfall.						Temperature.				Sunshine.	
	11-Year Average.			1946.			Maximum.		Minimum.		Mean Hours per day.	
	Inches.	Days.	" P."	Inches.	Days.	" P."	8 years.	1946	8 years.	1946.		
January...	2.06	6.9	0.09	1.13	6	0.05	84.2	87.4	59.5	59.4	6.1	5.1
February...	2.42	7.3	0.12	0.09	3	0.00	85.0	89.3	60.0	59.1	6.1	6.0
March ...	4.24	12.6	0.23	3.13	11	0.16	83.4	86.2	60.8	62.2	6.4	6.4
April ...	6.39	16.3	0.47	5.75	18	0.48	81.8	80.6	62.6	62.8	5.4	4.2
May ...	5.50	17.5	0.41	5.96	15	0.37	79.1	79.1	61.6	61.5	5.1	4.9
June ...	2.39	9.3	0.12	1.75	14	0.11	79.1	77.7	59.4	59.6	5.0	3.8
July ...	2.03	7.3	0.09	2.20	9	0.10	78.6	79.1	58.4	59.1	3.6	3.3
August ...	3.67	12.1	0.19	5.18	14	0.30	79.4	76.8	59.3	60.4	3.9	3.0
September	4.08	13.1	0.24	3.18	15	0.21	81.2	79.5	59.3	60.2	4.8	4.7
October ...	3.91	13.3	0.22	6.04	20	0.55	82.8	81.5	60.9	60.6	4.8	4.6
November	4.67	15.0	0.31	3.80	15	0.25	81.5	81.5	61.0	60.6	4.9	5.1
December	3.37	8.9	0.15	2.20	10	0.11	82.4	82.1	59.4	59.8	6.3	5.8
Total ...	44.73	—	—	40.41	150	—	81.5	81.7	60.2	60.4	—	—
Means...	—	—	—	—	—	—	—	—	—	—	—	4.7

" P "—The effective precipitation is evaluated as rainfall per day without rain during the period.

An attempt has been made to assess the net climatic effect by means of an appropriate index. It was considered that the accepted formulae for this purpose did not give sufficient weight either to days without rain or, perhaps of equal importance, to the prevailing cloudy days. Under conditions in this area, it has been observed that within five days of a reasonably satisfactory precipitation, quite severe wilting can take place. Further, it would appear that the cool cloudy days simulate what may most conveniently be described as a "green-house" effect.

In a preliminary investigation of this nature it seemed desirable to obtain the simplest index possible which was yet sufficiently sensitive to show differences likely to occur at this elevation (3900 ft.). Various modifications of the de Martonne formula were evaluated and were found to be unsatisfactory, since effective temperature variation at this altitude is not great. It was considered that mean daily hours of sunshine, as given by a Jordan Recorder, would be a more informative variate than temperature normals. The index finally chosen, a climatograph (after Ball—Taylor, see Uvarov, 1932), with effective precipitation and mean daily hours of sunshine for the two axes, appears to illustrate most efficiently the differences known to exist. Since the number of days without rain in any month is considered to be of great importance, the monthly precipitation was evaluated as the rainfall divided by days without rain during the same period, and is given as "effective" precipitation.

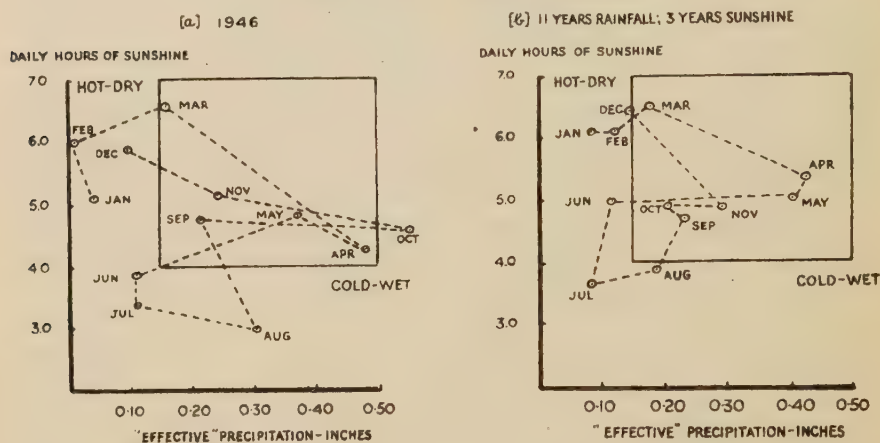
Unfortunately over the 11-year period for which rainfall data are available only three years' sunshine data were recorded. The

climatographs for the means so derived, and for 1946, are given in the diagram below.

FIGURE 1

CLIMATOGRAPHS FOR 1946 AND THE 11 YEAR AVERAGES.

WHERE "EFFECTIVE" RAINFALL IS GIVEN AS RAINFALL IN INCHES DIVIDED BY DAYS WITHOUT RAIN AND MEAN DAILY HOURS OF SUNSHINE IS EVALUATED FROM A JORDAN RECORDER



It will be observed that, for this area, there are two fairly well defined dry seasons having 0.15 in., or less, of rain per dry day. One may be described as relatively hot and dry, and the other, cool and dry. During the former, but little growth takes place under the semi-arid conditions then prevailing; for the latter, growth is inhibited by both reduced sunlight and low soil moisture. However, during this latter period, desiccation is not severe, so that established plants can survive and possibly extend their root systems more effectively than during the hot dry season.

GENETICS AND BREEDING.

(a) *Blackarm Resistance*.—Extensive series of backcross material were grown. These included those from the 1st to 5th backcross on to BP.52 of the gene B_2 obtained from B.181 or a derivative, together with two of the remaining backcrosses on to BP.52 of the B_3 gene from Gambia native.

During the season Dr. R. L. Knight visited the station at the time of the spraying operations. His subsequent report pointed out a serious disadvantage connected with the technique when conducted in this area. Under the climatic regime prevailing at the time (late July and early August), the Angular Leaf Spot phase of *X. malvacearum* appeared to be inhibited. Reference to Figure 1 shows that from June, when the breeding material was planted, until late August, extremely

cloudy conditions prevailed. Dr. Knight has pointed out that the rapid development of Angular Leaf Spot requires sunny conditions in addition to minimum rainfall requirements.

Since the grading for resistance is of course based on the extent of the restriction of leaf spots, Dr. Knight has suggested that further work on gene transference at this Station be suspended for the present at least. It is possible that the limitations imposed on the work by climate in this area do not apply to the same extent at Serere.

(b) *Verticillium Wilt*.—F₂ progenies from 30 F₁ single plants selected in the previous season were grown in an attempt to evaluate a possible mode of inheritance of resistance known to exist in the variety B.181. The susceptible variety BP.50 is of some importance in the north-eastern areas of the Protectorate. A chi-square test for a 3 : 1 hypothesis, on the basis of internal symptoms, indicated that there was no evidence to show that resistance to *Verticillium* wilt is inherited as a simple Mendelian character. It should be pointed out, however, that the inoculation technique does not appear to be completely reliable. Some investigations are being conducted at Rothamsted and Barberton in this connection, from which it is hoped that a more reliable procedure will result.

(c) *Other genetic work*.—Various hybrids made during the previous season were carried a stage further as backcrosses. These included the transference of Okra leaf, tomentose hairs and naked and tufted seed, all to the BP.52 variety. When the precise contribution to crop losses due to the more important insect pests is known, much of this material might prove of value for breeding purposes.

(d) *Multiplication*.—One of the most important aspects of the breeding work is that of maintaining and improving the BP.52 strains. With this end in view many single plant selections were made by the Senior Botanist. Of these, 149 were sent to Ukiriguru in 1945 for testing under conditions of relatively high jassid infestation. Following the results there achieved, sixteen of the hairiest selections were planted at Kawanda and will form the nucleus of the best BP.52 strains. During the course of the following seasons they will be put through a "filter" system analogous to that which has been so successful in the West Indies and the Sudan.

Variable bulks were maintained of all of the more important strains. In addition, single plant selections, made from the commercial crop, were grown side by side with their various progenitors.

At the end of the season approximately 10,000 lb. of high quality B/C.66 seed were released to the seed farm for multiplication. B/C.66 is a 3rd backcross to BP.52 and probably carries a fairly high degree of resistance to blackarm. In spinning tests carried out by the Shirley Institute, the quality of this strain proved to be at least as good as that of commercial BP.52.

(e) *Special Cotton Survey*.—A special survey was conducted, during the early part of 1946, in which samples of seed cotton from the BP.52 and N.17 areas were analysed for differences due to fertility, placement on the plant, localities and seed source. The comprehensiveness of the survey is indicated by the ginnery areas sampled, being 87 for the BP.52 area and 15 for the N.17 area. Amongst the several laboratory measurements carried out, it appears that lint per seed is that which, under these conditions, was least affected by random variation. The lint samples were sent to the British Cotton Industry Research Association for small scale spinning tests. From the complete data so obtained it was hoped to have some information regarding the most reliable of three possible sources of BP.52 seed, and also of the best general seed source for the N.17 area.

The laboratory analyses revealed large differences due to both locality and seed source. It was inferred from examination of these data that one of the most recent releases of BP.52 multiplication seed, which originated at the Research Station, Kawanda, was likely to be rather better than the others. Subsequent data for hair and spinning characters, the most reliable of which was the corrected leaf-count x strength product, substantiated these inferences. There were very large differences for all characters in the N.17 variety.

It is considered that the extensive seed movements which have since been proposed for the BP.52 areas will probably improve the uniformity of this high quality cotton. For the N.17 area specific recommendations are likely to be made in conjunction with the Empire Cotton Growing Corporation. There is some evidence that a general replacement of N.17 by BP.52 in certain areas would not lead to a material improvement in yield or possibly even in quality. In addition, the high incidence of *Xanthomonas malvacearum* in the areas of the north-east with more sunny conditions, coupled with higher rainfall, might make such a replacement by existing strains of BP.52 rather unsuitable.

The continued interest and promptness of handling by the Shirley Institute of such a large number of samples has contributed in no small degree to the value of the survey. Much valuable information regarding the hair and spinning characters of the commercial crop is now available.

AGRONOMY.

(a) *Sowing Date Trials*.

Food crops are usually planted in the cotton growing areas of Uganda with the first rains, beginning at the end of February; cotton is planted during or after the harvest period of these crops. Should the planting of food crops be delayed, almost invariably the cotton is planted "late." With such a system it is very desirable to know the latest planting date from which reasonably high cotton yields may be expected. The importance of this problem may be gauged by the value of the cotton crop to the cash economy of the Protectorate. Since it is not the invariable rule to plant cotton on the identical land

used for planting of food crops, there is some latitude allowable in the matter of time of planting of cotton. Further, in certain areas cotton is planted on newly opened land prior to the planting of grain crops in the following year.

Field experiments conducted over a number of years have shown generally that the earliest sowings of cotton have consistently out-yielded later plantings. Departmental propaganda was therefore directed towards encouraging early planting of cotton. In recent years some doubt has been expressed regarding the validity of the inferences from the early experiments. One of the possible criticisms has been that regarding the likely "build-up" of insect populations, notably *Lygus* spp., which could migrate from the early to later plantings in a contiguous experimental area.

In designing an efficient experiment to investigate further the optimum time of planting in relation to crop losses due to insect populations, there are several important considerations. It was accepted, for Buganda at least, that planting of cotton on dates earlier than mid-May, would have but little practical application. Again with isolated plots which might avoid this "build-up" of insect populations, locality differences would be likely to be of greater magnitude than differences due to planting dates. To overcome this latter disadvantage a "staggered" time of planting design, based on one put forward by Empire Cotton Growing Corporation Officers in Nyasaland, was amplified to include 10 fortnightly planting dates spread, in groups of three, over eight localities. The spatial isolation on an Experiment Station of this size was not great, but was considered to be adequate. The continuity between planting dates was maintained by having a two-thirds overlap in time. For convenience the layout (omitting the four replications of each treatment at every locality) is presented diagrammatically below.

DIAGRAM I

COTTON SOWING DATE EXPERIMENT. KAWANDA 1946-47

BASIC DESIGN FOR THE THREE DATE PLAN FOUR REPLICATIONS AT EACH LOCALITY

LOCALITY	PLANTING DATES [TREATMENTS]									
	1 MAY	15 MAY	29 MAY	12 JUN	26 JUN	10 JUL	24 JUL	7 AUG	21 AUG	4 SEP
1	1	2	3							
2		2a	3a	4						
3			3b	4a	5					
4				4b	5a	6				
5					5b	6a	7			
6						6b	7a	8		
7							7b	8a	9	
8								8b	9a	10

TREATMENTS ADJUSTED FOR LOCALITIES FROM $A_i \times C_{ij}$
$A_1 = 3T_1 - L_1$
$A_2 = 3T_2 - L_1 - L_2$
$A_3 = 3T_3 - L_1 - L_2 - L_3$
$A_4 = 3T_4 - L_2 - L_3 - L_4$
$A_5 = 3T_5 - L_3 - L_4 - L_5$
$A_6 = 3T_6 - L_4 - L_5 - L_6$
$A_7 = 3T_7 - L_5 - L_6 - L_7$
$A_8 = 3T_8 - L_6 - L_7 - L_8$
$A_9 = 3T_9 - L_7 - L_8$
$A_{10} = 3T_{10} - L_8$

WHERE T = TREATMENT TOTAL, L = LOCALITY TOTAL: FOR C_{ij} SEE TEXT

It will be observed that where the " build-up " of insect populations is likely to be a major contributory factor in crop loss, any one sowing date X would probably yield less than Xa, and this in turn less than Xb for planting dates from May 29th to August 7th. These latter represent the general range for commercial planting in this area.

With the analysis of the early design of this type, the relatively large differences between localities tended to obscure those which may have existed between sowing dates. Further the error term chosen was so inefficient that all but the very largest differences would be considered to be no greater than could have occurred by chance. For this newer design, therefore, it was considered desirable to adjust treatment means for the localities in which they occurred.

The writer is deeply indebted to Dr. R. L. Anderson, of the Institute of Statistics of the University of North Carolina, for providing a scheme of analysis whereby treatments are adjusted for locality difference from the identity $A_i \times c_{ij}$. Here the c - multipliers were derived from a least squares solution and the A_i values are indicated on the diagram. With this analysis the Treatment $\times$ Locality interaction provides an estimate of the extent to which treatment yields differ at different localities. That is, in the absence of a large and significant interaction, it would be concluded that there were no real differences in cropping capacity for the same treatment at different localities. Since the methodology might be of interest to other workers on the same problem, it is proposed to publish full details elsewhere.

Two such Sowing Date Trials were laid out during the season, one at the Kawanda Research Station and the other in Masaka. The site chosen in Masaka represents an area where rainfall at all times is uncertain, but the expectation of rain is probably greatest during the second half of the year. Since this trial was not begun until September 1946 the final yields are not yet available. This report deals only with the trial conducted at Kawanda.

That cotton plants suffer characteristic physiological disturbances due to certain climatic conditions is well known. Some attempt to relate growth and maturity to climatic conditions was therefore made. It is proposed to consider data from the Sowing Date trial, and in the later discussion to relate these to optimum time of planting on the basis of these and additional data available from a series of independent trials at various planting dates.

Summarized data for number of days to first flower, leaf damage per plant as a measure of capsid attack, plant height at 154 days, and seed cotton in pounds, all adjusted for locality differences, are given in Table II.

TABLE II.

SUMMARY OF DATA FROM THE SOWING DATE EXPERIMENT KAWANDA 1946-47. ALL TREATMENTS ADJUSTED FOR LOCALITIES.

<i>Treatment.</i>	<i>Number of days to first flower.</i>	<i>Leaf Damage per plant at 126 days.</i>	<i>Plant Height in inches at 154 days.</i>	<i>Seed Cotton per plot lb. per acre.</i>
1 = 1st May ...	99.1	4.5	39.0	803
2 = 15th May ...	101.8	4.2	38.9	828
3 = 29th May ...	102.6	4.7	40.4	776
4 = 12th June ...	99.4	2.7	40.0	741
5 = 26th June ...	104.2	2.6	37.5	617
6 = 10th July ...	99.1	2.7	41.9	622
7 = 24th July ...	98.8	1.4	40.5	533
8 = 7th August ...	93.2	1.0	38.2	422
9 = 21st August ...	90.6	0.2	36.2	295
10 = 4th September ...	95.3	(0)*	32.6	196
Significance of Differences (p)				
Localities (adjusted) ...	0.01	0.001	0.001	Very small
Treatment (adjusted) ...	0.01	0.001	0.01	0.001
Interaction (T-L) ...	0.01	N.S.	N.S.	N.S.

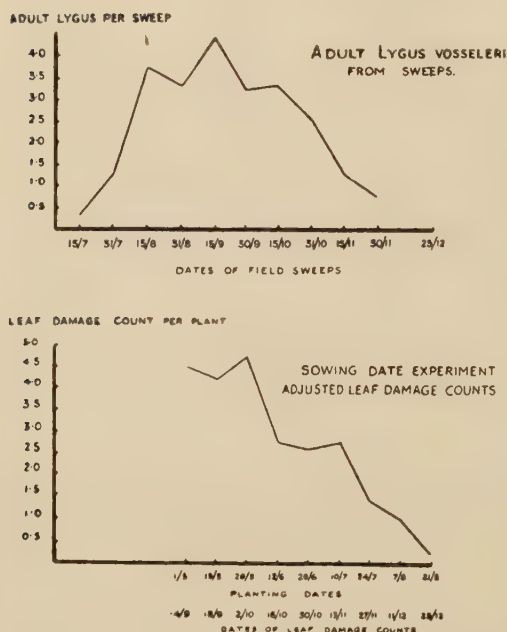
* The net effect was evaluated as a negligible negative value.

As might be expected in such a comprehensive trial, with planting dates spread over four months, and all at specific dates, germination was not uniformly good. However, with the exception of the planting on 26th June, the stand was good for all treatments. Reference to Figure 1 shows that conditions were poor for the relevant periods (i.e. 10th and 24th July). Later development as reflected in plant height was not good. The sowing on the 10th July though slow in germinating did not suffer to the same extent. The number of days to first flower shows a fairly well marked trend, with the exception of the 26th June planting, becoming first later, and followed, as hours of sunshine per day increased, by a material reduction. The node number, not included in the summary, showed but little variation between sowing dates. The interaction between treatment and locality showed that there were real differences between the same treatments at different localities. In general it was observed that X flowered before Xa and this before Xb, at any planting date.

Capsid damage counts were made at 126 days for each treatment. The procedure, evolved by the Entomological Section, was as follows:—The five most mature leaves immediately below the growing point are examined for damage on an arbitrary scale 0 to 5. For this experiment, planted at a spacing of 3 ft. × 1 ft. with two plants per hole of which 45 plants in each plot were examined, a fairly representative estimate of capsid damage was obtained. The actual dates of observation were at fortnightly intervals commencing on 4th September. From examination of the lower diagram in Figure 2 it will be observed that leaf damage showed a downward trend from the earliest to the latest planting date.

FIGURE 2

COTTON SOWING DATE EXPERIMENT, KAWANDA 1946-47
COMPARISON OF CAPTURED *LYGUS VOSSELERI* FROM 100 SWEEP
COUNTS, AND ADJUSTED LEAF DAMAGE COUNTS.



That leaf damage counts do in fact indicate the presence of *Lygus* spp. is suggested by the fairly close parallel with separate estimates of *Lygus vosseleri* made by the Entomological section from their sweep technique. Mean populations of adult *Lygus* are given in the upper diagram in Figure 2.

There was no interaction between locality and treatment for capsid damage, indicating that there was no "build-up" of *Lygus* from early to late plantings. On further examination of these data rather the opposite effect was indicated, that is, that the earliest treatment at any one locality appeared to have the highest damage counts. Since,

in a separate experiment with a large number of plots at one locality, there was a significant correlation between "flowering" and capsid damage ($r = +0.43$; $n = 95$), the interaction between treatment and locality for days to first flower in the sowing date experiment might be explained on this basis. That is, for flowering, the X_b 's which tended to be later had the higher capsid damage counts, presumably due to early bud shedding.

Plant height also showed the same sort of trend as days to first flower, with the greatest main stem elongation occurring with the least favourable climatic cumulative means, when a cool cloudy climatic regime prevailed.

Differences observed for these plant and other measurements were not reflected in the final adjusted yield data. That capsid as measured by leaf damage must certainly contribute to crop losses may be inferred from the relationship with early shedding. However a comparison between the capsid damage count (given in Figure 2) and the adjusted yield data (shown in Figure 3) shows that yield levels were extremely low for the lowest levels of capsid attack.

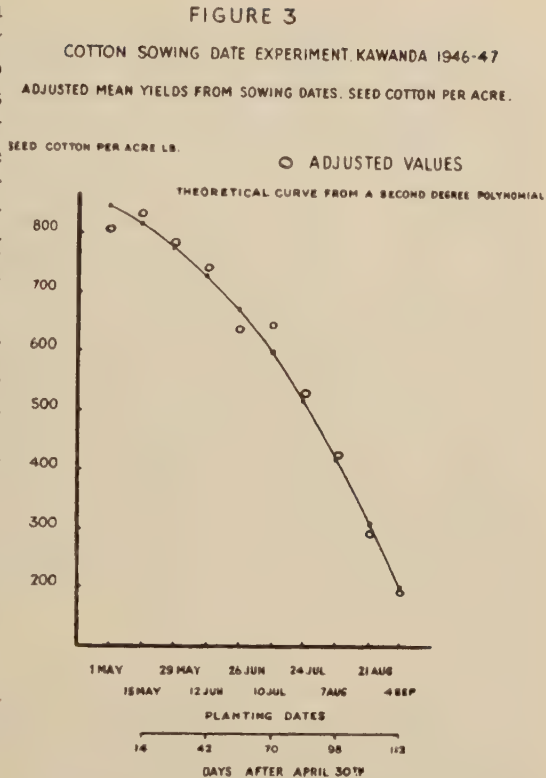
It is clear that factors other than capsid, though possibly of equal importance, have contributed to the extensive crop losses known to exist. There were some indications, which as judged by the magnitude

of the interaction between treatment and locality could not be considered to be significant, that insects other than capsid may have contributed to the crop losses of these later plantings. Undoubtedly the heavy rains during maturity were amongst the more important factors.

Summary of the Sowing Date Trial.—On the basis of this trial, conducted during one season, it must be concluded that of many possible contributory factors to crop loss, an unfavourable climatic regime is by no means the least important. Undoubtedly the relative importance of *Lygus* sp., and probably of *X. malvacearum* when sunshine is more intensive, must also be great. The lack of a significant inter-

action between treatment and locality shows that, while insect pests other than *Lygus* may have contributed to crop loss, there could have been no migration of great magnitude from early planted to later planted plots in any one locality. There was some evidence that, while "bolting" was a feature common to all planting dates under review, the very earliest and the very latest sowings tended to grow more efficiently; that is, the yield in relation to excessive vegetative growth, tended to be higher.

Much of the success of the earliest planted cotton is attributed to the fact that it was established prior to the onset of the cool dry season. Further, though no root system studies were attempted, it is probable that root penetration would be greater than for plants established during higher rainfall conditions. As a result then, when the "late" rains commenced, early planted cotton was less liable to physiological shedding such as was recorded for the later plantings. Since the period from planting to final picking of cotton under these climatic conditions is as long as 300 and not less than 240 days, it is not surprising that the very late plantings were unsuccessful. From the available evidence, it would appear that under similar conditions of climate, insect and pest attack, as were experienced during this past season, the earliest possible planting dates are likely to lead to the highest yields for this area.



Optimum Time of Planting.—Reference has been made previously to the characteristic physiological disturbances of the cotton plant under certain climatic conditions. In some cotton growing countries the term "bolt" has been adopted to describe this phenomenon. The effect, which is expressed as main stem elongation, is most pronounced where heavy rains occur before the onset of the reproductive phase (Hardy, 1946). It has been observed in Uganda that cotton plants in some areas, at certain seasons, develop the growth habit variously referred to as "Uganda habit" or "columnar" (Jameson, 1946). That climatic regime may contribute largely towards this growth habit in Uganda has been suggested by data from the Sowing Date trial above. It is reasonably certain that capsid attack and blackarm disease contribute largely as a result of the bud and boll shedding they cause. Undoubtedly one of the more immediate problems is to estimate the relative contribution to crop loss of each of these several factors before attempting remedial measures. The difficult nature of the problem is partially demonstrated by the fact that, under certain conditions in Uganda, crop losses due to *X. malvacearum*, even from strains of cotton homozygous for the resistant gene B_2 , appear to be quite considerable. Again complete experimental control of capsid has not yet been secured, so that its independent effect has still to be estimated.

Accepting the fact that these factors will continue to operate for some time to come, from the purely practical aspect it becomes necessary to ascertain the optimum time of planting while these factors continue to operate. With late maturing varieties such as BP.52, it may be inferred, from the sowing date trial at Kawanda, that the earliest planting date after 15th May is likely to lead to the highest yield for this area given a similar climatic regime. Reference to the climatograph in Figure 1 shows that such a climatic regime, with the characteristic dry months of June and July, follows the normal expectation. That the adjusted data from the sowing date trials do in fact measure the average effect on a larger scale is demonstrated by the yields from the 24 acres of multiplication grown on the Experiment Station. Thus the average planting date for Kawanda was about July 1st. The weighted average yield was just over 600 lb. of seed cotton per acre. From Figure 3 it will be observed that such would in fact have been expected on the evidence of the sowing date trial.

To widen the basis for inference, however, it seemed appropriate to examine available data over a number of years. Differences due to climatic regime would then more easily be apparent. For this purpose District Variety Trial data over the 9 year period 1938-46 were collated. A correlation surface was prepared for one of the two varieties common to all trials, namely B.181, and is shown in Figure 4.

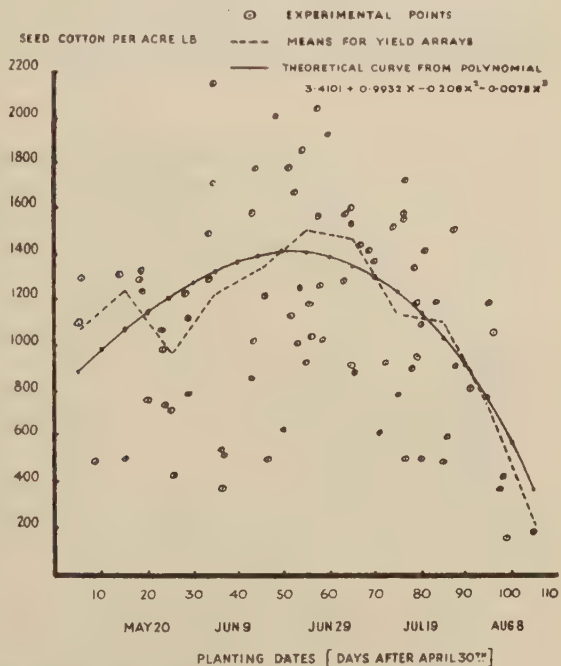
To facilitate the interpretation of these data the theoretical points are given by a third degree polynomial of the form $3.4101 + 0.9932 X - 0.0206 X^2 - 0.0075 X^3$, which was evaluated from a least

squares solution. The very general geographical nature of these data is indicated by the range of localities, from Masaka in the south of Buganda to Bulemezi in the north-east; in addition, areas in the western part of Buganda such as Bukomero and Kakumiro are included. The climatic regime prevailing over such widely scattered localities is often quite markedly different. Thus in parts of Bulemezi and near the Lake shore in Masaka, the Lake climate (Henderson, 1945) prevails. The characteristic feature of this climatic regime is a less well-marked dry period during June and July. This applies also

to other areas in the north-east which are not under discussion in this report. For other areas, of which Kawanda is representative, a dry period in June and July is equally characteristic. For this area, the late rains, though often greater in total quantity, are less reliable, and tend to fall in fewer but greater precipitations.

FIGURE 4

CORRELATION SURFACE SHOWING RELATIONSHIP BETWEEN
YIELD AND PLANTING DATE OF BIBI IN VARIETY TRIALS, 1938-46.



That there is a quite considerable variation between yield and planting date is demonstrable. The theoretical curvilinear relationship is therefore little more than an average effect. However, one inference may be drawn with some certainty, namely, that for these trials very late plantings have been uniformly unsuccessful. The success of the trials planted during the middle of June may be explained by the fact that trials, grown where the Lake climate prevails, can be established during June. Planting dates up to the end of June can be, and often are, successful in many parts of Buganda. However, it should be noted that all Uganda varieties are late maturing (under Kawanda conditions from planting to final picking often covers a period of 300 days). Much of the failure due to late plantings may therefore be ascribed to uncertain late rains, or, as was experienced during this past season in most districts, to heavy rains just prior to maturity. It is clear therefore that considerably greater crop risks are involved with later plantings. At the same time it is possible that quicker maturing varieties may be evolved for a planting date after

the cool dry season, and this might avoid the greater part of the capsid attack. Until such time, however, it would appear that early plantings, under existing conditions, have the greatest expectations of reasonably high yields. Where the June-July dry period is less severe, some latitude is allowable, but it should be noted that even in these areas a very late (after the end of July) planting period has not been uniformly successful.

TABLE III.
DISTRICT VARIETY TRIALS 1946-47.
11 LOCALITIES EACH WITH 5 × 5 LATIN SQUARE.
PLANTING DATES FROM 15TH JULY TO 13TH AUGUST.
ANALYSIS OF VARIANCE AS A SERIAL EXPERIMENT.

Due to	d.f.	S.S.	M.S.	F.	p.
Row	44	808.86			
Columns	44	605.26			
Varieties :					
MU.8A, B.181 and BP.52 Vs. BAR. 7/1 and Buganda Local ...	1	150.42	150.42	63.20	V.S.
MU.8A and B.181 Vs. BP.52 ...	1	13.00	13.00	5.46	0.05*
MU.8A Vs. B.181 ...	1	5.02	5.02	2.11	N.S.
BAR.7/1 Vs. Buganda Local ...	1	1.58			
Localities	10	11,180.74	1,118.07	469.78	V.S.
Localities × Varieties	40	455.83	11.37	4.78	0.001
Error	132	314.75	2.38		
Total	274	13,535.46	—	—	—

C.V. = 14.7 %. General Mean at the Rate of 706 lb. p.a.

SIGNIFICANCE OF DIFFERENCES BETWEEN VARIETY MEANS.

Yield of Seed Cotton lb. per acre.

MU.8A	B.181	BP.52	BAR.7/1	Buganda Local.
773	745	720	654	639

YIELD LEVEL OF LOCALITIES LB. PER ACRE.

Kalagala	Bukalasa	Nakifuma	Kyanamukaka	Mukono	Kawanda	Kakumiro	Bukomero	Kabasanda	Bulindi	Nkozi.
1,538	1,338	1,110	811	600	551	524	470	325	253	250

* Using the Locality × Variety interaction term in the variance ratio this difference is not significant at $p \times 0.05$

(b) *District Variety Trials.*

District Variety Trials were conducted at 11 centres in Buganda during the 1946-47 season. The individual 5 × 5 latin squares were analysed separately and collectively as a serial experiment. The statistical reduction of these data (for the serial experiment only) are given in Table III.

It will be observed that all but a few of the locality yield levels were of a low order, and variety mean yields were all low. This was a reflection of the general cropping conditions throughout all areas. Much of the differences ascribed to variety means is due to the orthogonal

comparison MU.8A, B.181 and BP.52 versus BAR.7/1 and Buganda Local. Of the remaining orthogonal comparisons, MU.8A and B.181 differed significantly from BP.52, but not from each other; and the difference between BAR.7/1 and Buganda Local was not significant at the $p = 0.05$ level. Since the locality $\times$ variety interaction was highly significant, it is probable that varietal differences generally should be interpreted with caution.

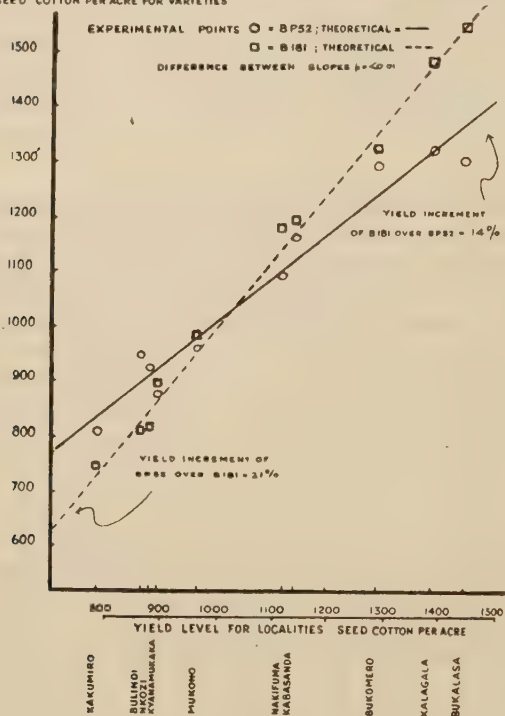
As might be expected with the wide range of soil and climatic conditions over such a large area, differences between localities were highly significant. Perhaps the most important aspect of the serial analyses is the highly significant variety $\times$ locality interaction, which confirmed that of the previous season. As the more appropriate error term, there was in consequence a reduction in the level of significance of differences between variety means. Thus while the main comparison differed significantly from the remainder, the differences between MU.8A and B.181 versus BP.52 were probably no greater than could have occurred by chance.

From the point of view of varietal suitability under a wide range of environmental conditions, the variety $\times$ locality interaction is of fundamental importance. To investigate this more fully, these data from ten centres for most of the 9 seasons 1938-46 were examined in some detail. During the period, the range of cropping capacity for locality means was from 750 to 1450 lb. seed cotton per acre. Further, the 10 centres chosen provide a fairly representative sample of the main cotton growing areas of Buganda. It should be noted that Kawanda, with but few years' data, was omitted because experimental planting dates, both very early and very late, have been outside the range of the remaining ten centres.

Only BP.52 and B.181 were grown in all trials, so that any later deductions must necessarily apply to these varieties. In studies of this nature, one of the most efficient methods for studying the relation between general fertility and varietal differences is that of using the artifice of the regression of mean yield on the difference of one variety from the mean of the others. By using the regression of variety on locality an equivalent effect has been achieved. Two regression equations were evaluated for BP.52 and B.181. The resulting data, showing both the experimental points and the theoretical linear relationship, based on 9 year means are presented diagrammatically overleaf.

The analysis of variance of these regression data revealed some extremely valuable information. Thus, while differences between variety means over the 9 year period were negligible, differences between slopes were highly significant. That is, the differences in cropping capacity under varying levels of fertility for the two varieties

FIGURE 5
REGRESSION OF VARIETY YIELDS ON LOCALITIES FROM VARIETY TRIALS 1938-46
SEED COTTON PER ACRE FOR VARIETIES



is most marked. Under relatively high fertility conditions B.181 out-yields BP.52 by as much as 14 per cent., whereas under relatively low fertility conditions the difference in favour of BP.52 is as high as 21 per cent. Further examination of the data which gave rise to these varietal means shows that, at the four centres of lowest fertility, in 24 out of 30 trials BP.52 outyielded B.181. At the three centres of highest fertility, in 20 out of 26 comparisons, B.181 outyielded BP.52. For the remaining centres (as might be expected from the regression pattern) there was considerable variation, though in 12 out of 18 trials B.181 out-yielded BP.52.

The high cropping capacity of B.181 under conditions of high fertility such as at Bukalasa, where the strain was evolved, is not unexpected. BP.52 also was selected at Bukalasa, but much of the subsequent selection has been conducted over a wider range of conditions. In addition it has rather fewer, though larger, bolls. The relatively poor performance of B.181 under the lower fertility conditions is, however, of some importance in formulating the most effective breeding policy. It is possible to make the generalization that growth and cultural conditions throughout the cotton growing areas are rather less suitable than those at Experiment Stations. Therefore, while B.181 has been shown by its yield performance to be the best strain on Experiment Stations, it now appears possible to explain its often disappointing performance under the more general field conditions. The yield synthesis of B.181 appears to depend largely on the development of a large number of relatively small bolls. Since in addition it is rather late maturing even amongst Uganda varieties, it is not surprising that it requires high fertility conditions for a maximum expression of yield.

It is clear that a further examination of a large range of varietal types must be conducted under the widest possible range of soil and

climatic conditions. It is possible that a variety with rather fewer, but larger, bolls might be more successful under general cultivation than B.181. In this connection BP.52 has a slightly larger boll than B.181, and BP.50 rather larger than BP.52. The inferences from District Variety Trials would suggest the general direction towards which the breeding policy at the major Experiment Stations should be aimed. For this reason, the relationship between these trials and breeding work is now stressed. For the coming season an intensive study will include the fullest possible details regarding previous cropping history and incidence of insect pests and diseases. In the meantime there appears to be no advantage in favour of the B.181 type over BP.52 apart from its resistance to *X. malvacearum*, except under relatively high fertility conditions.

(c) *Fertilizer Trials.*

The opening of extensive rock phosphate deposits at Tororo in the Eastern Province, and the possibility of obtaining comparatively cheap nitrogenous fertilizers in the future, were amongst the main reasons which led to the inauguration of a new series of fertilizer trials in Uganda. The ever existing need for increased production per unit area of cultivable land, more particularly from land cultivated continuously, was an equally important incentive.

In designing this series of experiments in conjunction with the Chemical Section, consideration had of necessity to be given to existing sources of fertilizer. In addition, the comprehensiveness was limited by facilities for the conduct of these trials. The basic question to be answered in these preliminary investigations was the extent to which yields from land in various stages of cultivation following opening were likely to be increased by the use of added inorganic fertilizers. Special attention was devoted to phosphate responses. At this stage no great importance was attached to the specific source of plant nutrient. Rock and silicophosphate, sulphate of ammonia and sulphate of potash were used throughout.

The details and results of these experiments are fully recorded in the Annual Report of the Department of Agriculture, but a summary of the more important features of some of these experiments with cotton and groundnuts is given in the table on next page.

The responses to silicophosphate have been in general disappointing. With the exception of a single trial with cotton in the Eastern Province, responses to the double dressing have been uniformly depressing. While at first thought it may be considered that the applications have been somewhat late, it has been shown that a small dressing, applied after planting, has given a satisfactory response with groundnuts. Further investigations, with germination, showed that in a 3³ trial with rock phosphate, nitrogen and varieties, there were highly

TABLE IV.
SUMMARY OF SOME FERTILIZER TRIALS 1946-47.

<i>Crop.</i>	<i>Cotton.</i>				<i>Groundnuts.</i>	
<i>Province.</i>	<i>Buganda.</i>		<i>Eastern.</i>	<i>Northern.</i>	<i>Buganda.</i>	<i>Eastern.</i>
<i>Locality ...</i>	Kawanda.	Kawanda.	Serere.	Ngetta	Kawanda.	Serere.
<i>Design ...</i>	3 × 2 ^a	3 ^a	3 ^a	3 ^a	3 ^a × 2	3 ^a × 2
<i>Treatments ...</i>	3 Varieties. 0 and 2 cwt. Sulp. of Ammonia. 0 and 2 cwt. Silico-phosphate. 0 and 2 cwt. Sulp. of Potash.	0, 1 and 2 cwt. Sulphate of Ammonia 0, 1 and 2 cwt. Silicophosphate 0, 1 and 2 cwt. Sulphate of Potash.			0, 1 and 2 cwt. Sulp. of Ammonia. 0, 1 and 2 cwt. Silicophosphate. 2 Varieties.	
<i>Varieties ...</i>	B.181, BP.52, BP. 50	BP. 52	BP.50	N.17	B.227 and B.239	
<i>Year of Cult. after Grass Ley ...</i>	2	2	1	3	3	2
<i>Planted ...</i>	28th May.	27th July	26th June	27th June	14th March.	24th March.
<i>Time Fertilizer application.</i>	6 Weeks after plant-ing.	At planting	2 Weeks after planting.	Before planting	At Flowering 4 Weeks after planting	4 Weeks after planting.
<i>Number of Plots</i>	72	54	54	54	72	72
<i>Spacing ...</i>	4 ft. × 2 ft.	3 ft. × 1 ft.	3 ft × 1 ft.	3 ft. × 1 ft.	1 ft. × $\frac{1}{2}$ ft.	1 ft. × $\frac{1}{2}$ ft.
<i>Plot size ...</i>	1/110 ac.	1/72 ac.	1/72 ac.	1/72 ac.	1/84 ac.	1/84 ac.
<i>Gen. Mean lb./acre ...</i>	862	651	852	1,381	2,600	2,130
<i>Conclusions ...</i>	Yield of B.181 and BP.50 > BP.52 $p = 0.01$ No Sign. Responses to fertilizer.	Phosphate Significantly Depressing Linear $p = 0.01$.	Significant Yield Increments due to N = 18.5%; P = 13.1%.	Significant Yield Increment due to N = 9.1%	Yield of B. 239 > B.227 Quadratic Phosphate Response Significant $p = 0.1$. $P_1 = 16\%$	Quadratic Nitrogen Response only Significant $N_1 = 16\%$

significant increments in germination at 12 days due to rock phosphate. These results were followed up in an experiment in collaboration with the Senior Chemist. In this experiment various treatments were tried, and it was shown conclusively that silicophosphate depressed the germination either of acid treated or untreated cotton seed. It is possible that for many of the experiments here reported the depressing effect of silicophosphate may have been due to its effect on germination, especially when the dressing was applied before or very soon after planting.

It is clear that caution must be exercised regarding recommendations to be made for the general use of silicophosphate in Uganda. While no specific advice can be given for rock phosphate, it has been demonstrated that its effect on germination is not similar to that of silicophosphate. Further it has been shown for millets that a large application, applied after planting, has been as effective as silico-phosphate in increasing yield. No information of real value is available, at this stage, regarding a possible nitrogen—phosphate interaction.

The effect of added nitrogen appears to depend largely on locality and soil type. In the Eastern Province, with lighter soils of inherently

lower fertility, responses have been obtained with cotton, groundnuts and *Eleusine*. In Buganda, with land of higher fertility, responses have been small and inconclusive. With such an uncertain indicator crop as cotton and possible differences in accumulated soil nitrates, much further work remains to be carried out. For the present it would appear that results to be expected from added inorganic nitrogen, on land in the first or second year of cultivation after a grass ley, are not likely to be of great magnitude. The possibility of obtaining large yield increments from land in successive years of cultivation after a grass ley is now being investigated.

There appears to be no obvious deficiency in potash as indicated by three trials with cotton. There are, however, some indications that further experiments, particularly with regard to nitrogen—potash ratios, should be conducted as opportunity permits. For the present it would appear that while cotton continues to be grown under cloudy rather than sunny conditions, the result so far obtained from added potash are not inconsistent with those obtained in other countries.

At a spacing of 3 ft. $\times$ 1 ft. for cotton, the opportunity for efficient plant development is somewhat restricted. Thus during the season under review higher yields were obtained from an early planted trial at a spacing of 4 ft. $\times$ 2 ft. Until more is known about the effect of climate on growth, the optimum time of application of fertilizers, the adjustment of spacing for varying fertility and the comparative value of rock phosphate versus silicophosphate, specific fertilizer recommendations must be held in abeyance. During the coming year further trials are to be conducted on land in the third and fourth year of cultivation.

ACKNOWLEDGEMENTS.

The writer acknowledges the valued co-operation from the Entomological Section of both the Senior Entomologist, regarding capsid data, and the Entomologist, who made some valuable suggestions regarding the presentation of the Meteorological data. Recent investigations in connection with the effect of fertilizers on germination of cotton seed were made in collaboration with the Senior Chemist, to whom acknowledgement is now made.

REFERENCES.

- Uvarov, B. P. (1932) Bioclimatograph, an Improved Method for Analyzing Bioclimatic Relations of Insects Ecology *XIII*, No. 3, July, 1932.
Hardy, F. (1946) Trop. Agric. *XXIII*, No. 11, p. 201-211.
Jameson, J. D. (1945) Repts. Expt. Stations. E. C. G. C. 1944-45.
Henderson, J. P. (1945) Unpublished Manuscript Relating to "Some Aspects of Rainfall in Uganda."
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PROGRAMME OF WORK FOR THE SEASON 1947-48.

1. *Breeding Work*.—Progeny rows from selected single plants of BP.52 are to be grown. Backcross material from previous blackarm projects is to be grown for sorting. Multiplication of bulks of the standard varieties is to be continued. Seed movements suggested by the special survey are to be implemented.

2. *District Variety Trials*.—Standard 5×5 latin squares are to be continued at all centres in Buganda. A variety with rather fewer, but larger, bolls is to be included with BP.52 and B.181. In addition a comparison will be made between the best BP.52 and that resulting from seed supplied by the nearest ginnery, as representative of the area.

3. *Sowing Date Trial*.—A sowing date trial is to be planted in February. It is hoped from this to obtain further information regarding the effect of this climate on growth and development.

4. *Fertilizer Trials*.—An extensive programme of fertilizer trials is to be conducted on a wide range of crops. For the Eastern Province, land in the first or second year of cultivation after a grass ley will be used. In Buganda, land in the first, third and fourth years of cultivation will be used. For this fourth year land with poorest structure, cotton will be grown on ridges. Amongst the fertilizer trials to be made, rock versus silicophosphate and inorganic nitrogen will be the most important.

SERERE AREA.**INTRODUCTION.**

The Botanist, Serere, proceeded on leave during the early part of 1947. The investigations here reported were conducted in the later stages by the Assistant Agricultural Officer. In presenting this brief summary, the Acting Senior Botanist, whose sphere was confined to the Buganda area, has drawn freely from the report of the Assistant Agricultural Officer.

METEOROLOGY.

The rainfall summary, presented in Table 1 below, shows the extent to which the season differed from the monthly averages for 26 years. For the first time on record no rainfall was recorded during the months of January and February. This early deficiency was more than made up during the months April to August. Excessive rainfall

during the months January to March 1947, did much to reduce the yields below expectation.

TABLE I.

Month.	1946.	26 Year Average.
January	Nil	0.79
February	Nil	2.37
March	4.06	3.56
April	10.83	7.95
May	8.21	7.34
June	6.94	4.41
July	3.57	4.53
August	12.25	6.68
September	4.94	5.99
October	1.96	4.32
November... ..	4.42	4.02
December... ..	1.27	2.01
Total	58.45	53.97

GENETICS AND BREEDING.

Breeding work at Serere has, during recent years, been confined largely to strain testing of various selections from the three standard varieties N.17, B.181 and BP.50. Resistance to the blackarm phase of *Xanthomonas malvacearum* has been considered to be of first importance. During this past season replicated trials were conducted with a view to estimating the cropping capacity of various blackarm resistant strains, compared with the parental types.

Separate variety trials indicated that for the N.17 group certain selections, notably S.4101, S.4106 and S.4108, had fewer blackarm lesions per plant and in addition gave higher yields of seed cotton than the N.17 standard. While the cropping capacity, during this season, of S.4108 was outstanding in this group, there was some evidence, itself inconclusive, that the mean lint length was shorter than N.17.

Differences between the B.181 selections were small and inconclusive.

Both of these trials were planted during the middle of July and it was recorded that blackarm lesions per plant tended to be rather higher for the B.181 group than for the N.17 derivatives.

A third small-scale variety trial in which inter-family comparisons were made, indicated that certain strains of the N.17 group outyielded the BP.50 and this in turn the B.181 derivatives.

AGRONOMY.

District Variety Trials.—The standard 5×5 latin squares were laid out at 19 centres. These centres are grouped according to fairly well defined ecological areas. For North-west Uganda, varietal comparisons include N.17 and its derivatives against BP.52 and BP.50. Those for South Lango and Teso include N.17 and its derivatives against B.181 and BP.50. The Bukedi area compares N.17 and its derivatives with BP.50 and BP.52. Finally for the largest cotton growing area of the Eastern Province—Busoga—the comparison consists of N.17 and its derivatives against BP.52.

Yields of seed cotton in pounds per acre from these District Variety Trials are given, for the planting dates, in Table II.

TABLE II.
DISTRICT VARIETY TRIALS FOR THE NORTHERN AND EASTERN PROVINCES.
YIELDS OF SEED COTTON PER ACRE 1946-47.

Area.	Locality Yield.		Sowing Date.	Variety Yields.				
	8-year Average.	1946-47.		N.17 Bulk	N.17 S.4101	N.17 S.4112	BP.50 S.5302	BP.52 Bulk
<i>North-West Uganda.</i>								
Ngetta	769	1221	2nd July	1142	1270	1187	1353	1151
Kitgum	838	880	22nd July	900	884	873	892	851
Gulu	702	819	26th July	837	873	763	788	832
Nebi	866	757	5th Aug.	804	809	706	721	744
Means	794	—	—	921	959	882	939	895
<i>South Lango and Teso</i>								
Kuju	465	562	27th May	560	627	541	537	544
Kumi	507	758	24th June	652	956	609	869	705
Kaberaimaido	653	696	25th June	574	666	711	727	601
Serere	728	693	29th June	523	911	549	748	733
Aduku	985	1467	1st July	1398	1721	1410	1517	1287
Means	668	—	—	741	1016	764	880	774
<i>Bukedi.</i>								
Bukedea	661	1058	26th June	1044	1206	925	1052	1065
Kibale	579	487	23rd July	486	565	484	409	491
Kisoko	669	705	24th July	583	944	619	642	735
Budaka	629	417	27th July	391	513	397	407	375
Means	635	—	—	626	807	606	628	667
<i>Busoga.</i>								
Bulopa	728	690	18th July	582	902	564	661	742
Bukula	880	905	18th July	801	1088	783	998	853
Bugaya	284	293	19th July	298	384	314	469	339
Nawanzu	817	1300	20th July	1348	1333	1283	1199	1330
Nakabango	1038	824	6th Aug.	596	823	721	964	1015
Means	749	—	—	725	906	733	858	856
<i>North Teso.</i>								
Katakwi	—	—	21st May	B.181 Bulk	B.181 KP.28	B.181 S.5301	SP.84 Bulk	BP.50 S.5302
				850	793	854	730	833

It is evident for this season that N.17 or its derivatives, have cropping capacities at least as good as selections from Buganda local which include S.5301 and S.5302.

Sowing Date Trials.—As for Buganda the question of optimum sowing date was re-opened. The nature of the climatic regime and the importance of food crops limit the possible sowing dates to the period mid-May to mid-August, for the Northern and Eastern provinces.

Two sowing date trials were conducted during the season; one included 5 varieties at 3 sowing dates and the other a single variety also at 3 sowing dates. From the former there was no differential yield response due to variety at the different planting dates. As a result the precision of the comparisons at different dates, being based on a larger effective number of replications, provided an accurate estimate of the likely response due to different planting dates.

Data for this trial are summarized in Table III and it will be observed that the highest yields were recorded from the earliest plantings.

TABLE III.
VARIETY AND SOWING DATE TRIAL.

(a) BY DATES :

Sowing Date.	% Stand.	<i>Lygus</i> Damage per Plant.	<i>Blackarm</i> Lesion per Plant.	Seed Cotton lb./acre.	Ginning %	Mean Lint Length mm.
20th May	67.8	0.3	2.6	849	33.2	33.4
17th June	75.2	1.1	2.5	564	32.9	33.8
15th July	85.7	0.4	3.6	498	32.5	34.0

(b) BY VARIETIES.

	% Stand.	<i>Lygus</i> Damage per Plant.	<i>Blackarm</i> Lesion per Plant.	Seed Cotton lb./acre.	Ginning %	Mean Lint Length mm.
BP.52	78.8	0.6	2.8	618	33.1	34.7
SP.84... ..	73.8	0.5	3.2	614	34.3	33.3
BP.50	75.8	0.7	1.9	724	32.4	34.7
N.17	74.5	0.6	4.8	574	31.6	32.1
B.181... ..	78.4	0.6	1.6	653	32.9	33.8

The aim of the second trial was to ascertain whether contiguous plots at different planting dates result in a migration of insects from earlier to later planted cotton. Where such a migration does take place on a large scale, the advantages demonstrated in former years as being due to early planting, would be largely vitiated. Insect attack, particularly *Lygus*, was of low intensity on all plots. The yields from the three dates 20th May, 20th June and 20th July were 714 lb., 612 lb. and 600 lb. per acre. While these data were essentially similar to those of the other sowing date trial, and others conducted in previous seasons, the information regarding insect migration was necessarily inconclusive.

The inferences to be drawn from these most recent, and previous sowing date trials, conducted at Serere, indicate that earlier planted cotton almost invariably gave higher yields. It is possible that the growth habit of the earlier planted cotton is less efficient than of later planted cotton; the appearance of the earlier planted cotton is generally of excessive vegetative growth. However, until such time as a short term cotton may be evolved, which can mature under Eastern Province conditions from later planting, it would appear that less crop risk is involved when cotton is planted during June.

PROGRAMME FOR 1947-48.

Pending the appointment of a Botanist, the programme will be considerably reduced. The more important projects are as follows :—

1. Maintenance of Breeding stocks of the main varieties N.17, BP.50, B.181 and BP.52.
2. Small scale family testing of the most prominent recent selections.
3. District Variety Trials at 19 centres in the Northern and Eastern Provinces.
4. Combined Sowing Date and Variety Trial.

TANGANYIKA TERRITORY.

LAKE PROVINCE.

UKIRIGURU AND LUBAGA EXPERIMENT STATIONS.

PROGRESS REPORT FOR THE SEASON 1946-47

BY

A. N. PRENTICE.

COTTON, UKIRIGURU.

Planting Period.	Picking Period.	Legal Uprooting Date.	Rainfall.		Notes.
			Amount.	Distribution.	
Nov.-Dec., 1946, into Jan., 1947	May onwards, 1947	7/9/47	48 inches	Good	Other areas much as Ukiriguru this season.

INTRODUCTION.

Staff and Development.—Mr. J. E. Peat went on leave and study leave in July; Mr. A. N. Prentice then moved from Lubaga to Ukiriguru. Mr. J. F. Tregarthen was Agricultural Assistant at Ukiriguru for the whole season. Ukiriguru, which is rapidly expanding, will henceforth be the base for two Corporation officers, and also for a strengthened Departmental staff as soon as housing allows. Lubaga, in its experimental aspect, will for the present continue as a sub-station of Ukiriguru; the Departmental officer housed there, at present Mr. J. T. Purvis, will spare what time is possible from many other duties to the farming of Lubaga. Most of the African Recorder staff of Lubaga have been transferred to Ukiriguru, leaving only a nucleus at Lubaga.

About 350 acres of land, 300 of the "hill-sands" series and 50 of the heavy black "mbuga" type, have just been added to Ukiriguru and will add greatly to the effectiveness of the Station. This land, coming as it does out of native cultivation, is comparatively easy to clear, level and fence, though for a number of years the irregularities must handicap experimental work. An appreciable fraction of it will be ready for use in the 1947-48 season.

The building programme, a heavy one which is expected to take several years, is in the hands of the Public Works Department. Housing for European and African staff takes precedence over other building, and some progress is being made.

Visitors.—Among visitors to the Stations were Dr. B. A. Keen, now director of the new East African Agricultural Research Organization and Dr. E. B. Worthington, Scientific Secretary, East African Governors' Conference.

The E.A.A.R.O. has got down quickly to fertilizer problems, and a fertilizer team, under Mr. L. R. Doughty, is already at work in three main areas of East Africa where population is dense and the maintenance of soil-fertility urgent. One of these areas is the Lake Province of Tanganyika, and Ukiriguru is now being used as a base for the team, the Stations and the district plots fitting in well with the scatter of soils wanted for the fertilizer experiments. The advent of this team is particularly welcome as it will be able to deal thoroughly with one aspect of soil-fertility to which in the past the Stations had been able to make only a part-time and therefore inadequate approach. It need hardly be said that the fullest co-operation is being maintained with the investigators.

Commercial Crop, 1947.—The Lake Province lint production for the year is estimated at around 32,500 standard bales, once again about average for the Province. The exceptionally wet season penalized some cotton, and favoured some. Especially in the north a considerable amount was late planted—because of the food-planting requirements; this late-planted cotton on the whole yielded poorly. In Mwanza district, though there was a considerable acreage, the amount of late planting, plus severe jassid and blackarm loss, reduced output. The Musoma district crop was a record. Thus the final provincial production was achieved as something of a compromise between unfavourable and favourable influences.

Weather.—The season's rainfall of 48 inches was high, 20 inches over average, and the distribution was good. The season suited crops—although the xerophyte cotton might have done better on less rain—and food-crop production was so good that the Province was again more than self-supporting after a run of near-famine years. As a generalization, good rains mean good crops in the Lake Province, which adds weight to the view that drought is the chief farming hazard in semi-arid East Africa. Other very obvious lacks and faults, of course, contribute to the low or erratic yields in this part of Africa, but moisture is often the determining factor, the "nutrient" in shortest supply. An example of how yields are influenced by good rainfall is provided by the "Exhaustion" plots at Lubaga. These plots, on a good black loam and under standard cultivation, continue to grow the same crop year after year with nothing put back and all crop-residues, except roots, carted off the land. An acre under sorghum has just given its heaviest-equal crop in this its twelfth year. An acre of cotton also in its twelfth year has given its record crop. The absolute level of yield in these plots was not particularly high—of the order of 1,000 lb. grain and 700 lb. seed cotton. A quarter-acre plot of groundnuts, running for only a few years and with crops so poor in the recent droughty years that, admittedly, cropping could have been no strain on the soil's resources, has now given its record yield at the surprising rate of well over a long ton of unshelled nuts to the acre.

GENERAL ACCOUNT OF THE WORK OF THE SEASON 1946-47.

HUSBANDRY.

Land Resting.—Most of the preliminary Ukiriguru resting-crop trials were under cotton as the indicator crop in 1945-46, and under grain in 1946-47. It may be remembered that the 1945-46 Ukiriguru report mentioned that apparently as early as the second year of the cropping cycle, no benefit resulted to cotton from the resting treatments; benefits from the incorporation of resting-crops had seemingly been dissipated in the first cropping year. Whether because cotton is a poor indicator crop, or because of the marked difference in the two rainy seasons, the 1946-47 grain indicator (bulrush millet) on these same trials showed a significant* benefit from the resting treatments, i.e., the benefit seems to have skipped the second year and reappeared in the third. For example, the treatment of rest under elephant grass for three years, compared with the control treatment (continuous millet), showed an increase of 38% in the first cropping year, was negligible the second year and was 34% this third year.

In two further Ukiriguru trials, just broken out of three years' rest and planted to bulrush millet, elephant grass and pigeon pea treatments, which had been grazed fairly heavily at intervals once thoroughly established, were usually about 40% ahead of the continuous-millet control, with pigeon pea rather the better of the two. Cassava, which had been allowed to go weedy once established, one of the resting crop treatments, also gave a significant increase of 30% over control in one of these trials. The picture of what happens on these light soils after a resting crop is still far from clear.

At Lubaga, on good black loam, a resting-crop trial in its second cropping year had both grain and cotton as indicator crops. This second year both cotton and grain showed a benefit of the order of 35-40% from three years' rest under elephant grass, when compared with their respective continuously-cultivated non-rotated controls, but a benefit only of the order of 15-20% when compared with continuously-cultivated but rotated controls, which is possibly the fairer comparison. By itself, simple rotation of cotton and sorghum seems to account for some benefit to both indicators by the fifth year of continuous cultivation. Composting at 5 tons per acre was giving around a 25% increase over nil controls, but the residual effect of organic manures on Lubaga was again small (in marked contrast to experience at Ukiriguru on the hill-sands). Another resting-crop trial at Lubaga, under grain in the opening year of its cropping cycle, was showing roughly equal benefits of around 50% over the continuous-crop control from three years' *Cenchrus ciliaris*

* $P = .05$, the level adopted throughout.

grass, three and two years' elephant grass, two years' weed fallow, and one year's velvet beans ploughed under as green manure. Much has still to be learnt about resting-crop effects on the heavier soils also.

At Lubaga a rest treatment, Kavirondo Hybrid Sorghum grass, was mentioned last year as having a depressing effect on its succeeding indicator crops in the first cropping year; this second year, the depressing effect is still noticeable with the grain indicator, but has disappeared with the cotton.

Manuring and Fertilizing.—The residual effect of farmyard manure (or, equally, compost) was again marked on Ukiriguru: a 7-ton-per-acre dressing was still giving a 38% increase over nil control in the third year, under cotton. Lighter dressings, however, showed no significant residual effect. Cotton-seed ash at $1\frac{1}{2}$ tons per acre showed a 34% residual benefit in the same trial. In another trial, under grain, a fourth year effect from 7 tons of organics was still appreciable at around 28%, and an effect was also discernible from the heavy dressing of 3 tons of cotton-seed ash. Direct and second year effects, in other trials, were much as usual. No analyses have been made up to the present of the farmyard manure and compost used in these trials.

A green manuring treatment gave a big increase in the grain constituent of a grain-interplanted-legumes crop, but at the expense of a corresponding drop in the legume constituent (groundnuts, cowpeas and grams). In the same trial a 400 lb. per acre dressing of Uganda raw rock phosphate in its first residual year gave no increase in either constituent. (These mixed-crop yields are difficult to express as a single term.)

The direct effect of silicophosphate (19% P_2O_5) at 400 lb. per acre in another trial on a grain-interplanted-legumes mixture was to increase the grain by 34% but to leave the legumes virtually unaltered compared with the control. In the districts, pairs of silicophosphate plots (cotton) gave varied responses, occasionally large, often nil. On Ukiriguru, cotton gave a negligible response to silicophosphate. An N.P.K. trial was incomplete because potash was unavailable, although from what evidence there is potash seems unimportant. This trial, under grain, was late planted and gave low yields, but 100 lb. per acre of sulphate of ammonia gave a marked effect, 36% increase over nil, whereas silicophosphate at either 200 lb. per acre or 400 lb. per acre gave increases averaging around 12% with or without nitrogen. At Lubaga, silicophosphate was giving around the same increase, 10% on cotton.

The importance of N, the lesser importance of P (this time in the form of superphosphate), and the lack of response to K on the hillsands of Ukiriguru were further borne out by the results from a trial run of micro-plots. Mr. R. V. Holme, of I.C.I., the originator of the

micro-plot technique*, was able to see it in use at Ukiriguru in September.

Tie-ridging.—Despite the unusually wet season, tie-ridged crops did not suffer from the water-logging which had been feared, except on land with an impervious subsoil which is always subject to water-logging.

A trial on the hill-sands at Ukiriguru put the yield of cotton on well-made ridges, tied, 50% ahead of that from ridges made native-fashion without tying. A sister trial under a millet crop showed no significant difference between the two treatments. On the heavier soils of Lubaga, tie-ridged groundnuts yielded a significant 24% better than those grown on the flat, tie-ridged cotton was much the better, and only bulrush millet showed a depression (which was not significant) due to tie-ridging. On the balance of the evidence, therefore, tie-ridging helped the immediate yield even in a year of heavy rains; and the control of erosion by tying was, of course, more important than ever. This yield benefit from tie-ridging, in a year of heavy rainfall, is of great interest and was not anticipated.

Under pressure, the measure is making a little headway in the districts. The cultivator admits the benefits, but objects to the extra work involved at the time of the planting rush, when his instinct is to plant the largest possible acreage by the traditional methods of cultivation.

COTTON BREEDING.

Cotton yields were varied, some fairly good, some poor. Late planting reduced yields in the North and jassid damage was serious in parts. American bollworm damage was very severe on otherwise good cotton at Lubaga. Crops on the heavy black valley-bottom soils suffered from water-logging. Blackarm was present at all centres. In some of the district plots which escaped insect damage yields were high; two plots at Nassa both averaged more than 1,400 lb. per acre seed-cotton over large strain trials.

U.K.46.—As mentioned in last year's report, the strain mixture *U.K.46* is being bulked to replace the present commercial cotton of the Lake Province, *Mz.561*. Simultaneously with the bulking it was being tested for the first time as an entity, and it came fully up to expectations in the field. Its seven component strains were also included in all trials, and the yield of *U.K.46*, calculated from its pure components, nearly always agreed with its observed yield to within

* As the name implies, the method consists of using diminutive plots, each 2 ft. × 2 ft. with an empty guard-border of 2 ft. all round. The essence of the idea is to use seedlings (maize or other) to make a rapid test of the nutrient-status of the soil with the usual three-level N.P.K. design of 27 plots. The seed is soaked; 45 (say) are planted per plot with the placed fertilizer; thinned to 30, left to grow for a month, then counted, pulled up by the roots and weighed. The native recorders on Ukiriguru, once they had grasped the method, carried through several successful trials with little supervision. The area used is so small that it can feasibly be watered and trials can therefore be carried out in the dry season if desired.

10%. The benefit of mixing, as anticipated, lay in the steadying influence on yield: U.K.46 naturally held a middle course, and, in general, a comparatively even course, while its components were variously up at one centre and down at the next.

In seed-cotton yields, U.K.46 averaged 25% better than Mz.561 over the seventeen strain trials of the Stations and the district plots. This highly satisfactory increase was rather better in terms of lint, as the Station ginning percentage of U.K.46 (average of six trials) was 34.1% against the 32.8% of Mz.561. The trials all carried 25 strains, and U.K.46 ranked on the average ten positions higher than Mz.561 and was ahead on 14 out of 17 occasions.

Jassid resistance was one explanation, and doubtless the main one, of the relatively good behaviour of U.K.46. Its degree of resistance to blackarm, however, is admittedly no better than it should be. The next issue of seed contemplated for the Lake Province will have special attention given to blackarm resistance, and, indeed, this is already foreshadowed in the provisional ingredients of a probable U.K.48 mixture now under study at Ukiriguru. This issue of a mixture of strains was discussed with Mr. J. B. Hutchinson when he visited Tanganyika last season.

The spinning results on U.K.46 are not yet available but the component strains have given conflicting results *vis-à-vis* Mz.561; it is expected that U.K.46 itself will prove a spinner of much the same general quality as Mz.561. The multiplication of U.K.46 is in the hands of the Agricultural Department, and the Crop Supervisor at Nyamahona, Mr. von Freeden, has given particular care to the first stage in the multiplication. The increase this season was just under twenty-fold. The commercial ginning percentage was 33.6% as against the 31.9% of Mz.561 from a similar area.

The internal development of the U.K.46 mixture will be interesting to follow over the years. The amount of natural crossing that takes place is considerable, probably of the order of 25% between immediately adjacent plants as mentioned in last year's report; at the moment the separate strains can be fairly readily spotted in the mixture. Strain-place interaction seems to be more marked than was at one time thought, and could conceivably lead to fairly rapid natural selection of the locally best adapted types in the mixture, especially if each centre or zone were to have a self-renewing seed supply: some Ukiriguru-bred and Lubaga-bred strains do markedly better on their respective "home grounds" than they do away, even although Ukiriguru and Lubaga are barely 80 miles apart. The respective environments, however, show considerable differences.

Other Strains.—The best of the local strains fully held their own with the good "foreigners" this year, seasonally an entirely abnormal year, but some of these introductions put up very good performances.

Conditions suited a derivative of Uganda B.P.50, and it was the leader in several of the district trials, in marked contrast to last year when, as mentioned in the report, "B.P.50 lots, though good looking, were amongst the lowest yielders in the trials." They have good jassid resistance, much better than that of most B.P.52 derivatives.

M.U.8 was among the yield leaders this year. Of its derivatives from crosses with Barberton U.4's, A.2195 was rather better than A.2208, although neither was as good as the M.U.8 parent in the field. M.U.8 was, if anything, superior to A.2106 over the run of the dozen trials they had in common, but A.2106 was far ahead of the other Barberton U.4 $\times$ Cambodia strain in the trials, A.2120.

An interesting collection, mainly of Upland types, was received from Shambat. Particular interest attached to the blackarm status of the types as expressed under Ukiriguru conditions, compared with the Sudan grading.

PESTS AND DISEASES.

Jassid.—Except in the south, jassid attack was heavy, especially on poor land, and undoubtedly helped to curtail the commercial cotton crop. Mz.561 suffers if jassid is at all heavy. Late-planted cotton was often reduced to a very low level of yield. The wide spread between the yield leaders and Mz.561 in the trials must have been partly a reflection of jassid damage. Mz.561 is by no means an unfruitful type where conditions are right, but at many of the trial centres this year it was yielding something like half the crop of the leaders. The season helped to drive home the lesson that jassid resistance is of the greatest importance for the industry in the Lake Province. From a better strain, the grower can get something for nothing, except for the extra labour of picking, and although he will often not get full value from the potential difference because of faulty farming, the influence of a jassid-resistant strain on production can still be considerable.

Stainers.—Damage from *Dysdercus* and *Calidea* stainers was light on the whole, by the usual standards. At Lubaga, the percentage of grade C cotton in the main block was 20%, damage enough, but not crippling. Poisoning by sodium arsenite is now carried out as routine on Lubaga if a stainer attack appears to be developing. In one field, which had four poisonings during the season, the percentage of grade C dropped in successive pickings—an unusual course—from the 50% mark to nearly nil, almost certainly due to poisoning. A field trial of various insecticides was started too late to produce results of any value.

Bollworm.—American bollworm, *Heliothis armigera*, and Spiny bollworm, *Earias* spp., were both very heavy on parts of Lubaga, while American bollworm was also a factor in the low yields from the late plantings on Ukiriguru. Over the Province as a whole they were not seen or reported as doing abnormal damage, though each year they cause

considerable loss throughout the Province. Maize, for once a very heavy crop on Lubaga, could have built up the American attack which reduced the setting crop on a magnificently grown strain-trial from a potential ton of seed-cotton per acre to a humdrum 600 lb.

Blackarm.—*Xanthomonas malvacearum* in the blackarm stage was widespread, probably universal throughout Sukumaland. Although no measured assessment has been made of the crop loss attributable to blackarm, this disease must fairly obviously share with jassid the responsibility for many a poor crop this season, especially under the poorer conditions. The very good growing season helped the plants either to grow away from the attack or to set a crop in spite of it.

The disease has come to the fore in the past few years, and is being treated with respect. Blackarm resistance is one of the main aims of the new U.K.48 mixture which is to follow U.K.46 (itself mixed for resistance). The components are being tested and recorded as thoroughly as possible in common with all strains on the Station. A first use of the spraying technique this season gave no results, but further acquaintance may make it a more useful tool in the coming season. Shambat has already supplied some data on local strains sent there for analysis and for the incorporation of blackarm resistance by Dr. Knight's methods. Some of the later Ukiriguru selections contain a higher proportion of resistants than the original bulks, and a tentative suggestion from Shambat is that each stage in selection has resulted in a gain in resistance, blackarm having been serious enough to have affected selection. The loss due to blackarm under local conditions is still guesswork, however; the potential loss looks obvious and large, and yet the heaviest-yielding strain over all trials this year, a local selection numbered 4/112, from Lubaga, where in most seasons blackarm is not such a factor as in the north, not only looked thoroughly susceptible here, but was graded at Shambat as containing virtually no resistance.

Ascochyta Blight.—At Lubaga, one small patch of cotton developed a killing disease, which was identified by Dr. G. B. Wallace, Plant Pathologist of the Department, as "*Ascochyta gossypii*." Dr. Wallace, who visited Lubaga and saw the disease in the field, will probably publish a note on it in an appropriate technical journal. He says of it:—"It has not been reported in this territory previously, but Hansford records it as a leaf-spot in Uganda. It was first recorded in India in 1908 and in the U.S.A. in 1920. . . . All accounts agree that the fungus is an active parasite (sometimes epidemic), attacking all parts except the blossoms, and that its occurrence coincides with wet weather. It can continue to live saprophytically on dead cotton plants . . . there is apparently no record of it on other hosts."

The disease started in February, but was confined to a patch of a few yards square, and within a month of attack seemed to be over. Within the patch, most of the plants were killed outright; the rest, although badly battered, were making an attempt at regrowth

in April. The plants from a distance had a blackish look ; the foliage was soon shed ; and cracks in the stems were very obvious. To the layman the disease looked at first sight like a combination of very bad blackarm and hail damage. The disease was not found elsewhere on the Station.

SUMMARY OF MAIN RESULTS.

1. Crops were fairly good, on the whole, in a year of exceptionally heavy rains ; but cotton suffered from jassid, blackarm and in places water-logging. Late-planted cotton yielded poorly.
2. Last year's provisional conclusion that at Ukiriguru, on light land, the benefits from a three-years' grass rest had been dissipated in one year's cropping, has to be modified : a significant benefit has reappeared in the third year.
3. The benefit from 7-ton manurial applications was noticeable in the third and fourth years, on the light Ukiriguru soils.
4. In N.P.K. trials the effect of nitrogen was large, of phosphate small and of potash negligible. The micro-plot technique promises to be useful.
5. Tie-ridging was still of value to yield, even in a year of heavy rains.
6. Jassid damage was heavy in most areas, and jassid-resistant strains showed to real advantage. Better jassid-resistance was doubtless the main reason for the superiority of the new strain mixture, U.K.46, over the commercial Mz.56r which it is to replace. U.K.46 outyielded Mz.56r by an average of 25% in 17 trials throughout the cotton belt.
7. Blackarm was widespread, and the next proposed issue of seed to follow U.K.46, another mixture, has blackarm resistance as one of the main aims. Shambat is helping with the work on blackarm.

PROGRAMME OF WORK FOR SEASON 1947-48.

Land Resting.—First, second, third and fourth year effects of various resting-crop treatments will be under trial at Ukiriguru and Lubaga, forming part of rotation and mixed-farming studies.

Manuring and Fertilizing.—Direct and residual effects of manures, fertilizers and green-manures will be under trial on various soil-types.

The fertilizer team of the E.A.A.R.O. is running a comprehensive series of experiments, covering all the major soil-types in Sukumaland and the Lake Shore areas of Mwanza district, using staple food-crops

(grains) as indicators. For the time being Ukiriguru will continue a fertilizer experiment on cotton and one on rice.

Agricultural Practices.—A series of experiments will test: broadcasting versus placing of fertilizers and manures, and time of application of fertilizers; various modifications of cultivation practices; methods of seeding short-grass leys; methods of ley management and breaking; methods of witchweed control. The help of Mr. H. L. Manning and Mr. L. R. Doughty with the design of various trials is gratefully acknowledged.

Cotton Breeding.—Selection and testing—with particular attention to jassid and blackarm resistance—will follow the usual sequence. Shorter-linted cottons such as M.U.8 will get some attention in view of possible sterling needs. Strain trials will take place on land in states of both high and low fertility. Plot shape as affecting jassid attack in strain trials will be under test.

Pests.—If insecticides are available, tests against stainers and stalk-borers will be carried out in co-operation with the Department's entomologist, Dr. Jepson.

Miscellaneous.—Other work, including that on rice at Mwabagole, continues as usual. Observation plots of various grains and cover crops collected in the United States by Mr. D. Thornton of the Department will be grown at Ukiriguru.

EASTERN PROVINCE.

PROGRESS REPORT FOR 1946.

BY

A. G. BEBBINGTON.

Planting period	...	...	...	Mid-February to mid-April.
Picking	...	...	...	August to October.
Uprooting	...	...	...	31st October.

INTRODUCTION.

The report covers the work on the main station at Ilonga and on the six district plots. The area under cultivation at Ilonga remained the same at forty-five acres. Clearing and surveying of a further block of one hundred and fifty acres was started.

WEATHER.

The "short" rains commenced in December and continued into January. There was practically no rain in February, while that in March was very irregular. Heavy rain fell in April. The rains ceased abruptly in the middle of May, and this shortened the growing season.

AGRICULTURE.

The production of foodstuffs was again the main point in the agricultural policy, but quite a large acreage was planted to cotton. The incidence of insect pests was much less than in the previous season and there was a considerable increase in production.

Growers appeared to be satisfied with their yields and the prices, particularly the increase in price paid for the lower grade cotton.

Planting at Ilonga and on the district plots was carried out during March under very difficult circumstances. Droughty conditions prevailed during the planting period, and germination was so poor in the district plots that all first plantings had to be hoed out and planted again.

Three spacing trials were laid down, but no results were obtained owing to the poor stands.

COTTON BREEDING.

The testing of different varieties and strains, particularly with regard to their reaction to insect pest attack, was repeated.

The variety trial of the previous three seasons was planted again. The types used were Eastern Province Local; Uganda B.P.52; Mwanza 561; B38/9, a selection from Eastern Province Local; and M.U.8A, a selection from Malwa Upland. The last was included on account of its high rate of flowering and early maturity.

The trials were carried out at Ilonga and on each of the six district plots in the same layout as previously, a randomised block design with six replications. The yields are given in the following tables. They are much more comparable than in 1945 as all the trials were planted more or less at the time same.

YIELDS IN LB. OF SEED COTTON PER ACRE.

<i>Place.</i>	<i>M.U.8A.</i>	<i>B38/9.</i>	<i>B.P.52.</i>	<i>Local.</i>	<i>Mz.561.</i>
Ilonga	658	633	611	553	602
Mgera	434	426	296	310	289
Morogoro	714	598	628	589	570
Kingolwira Village	—	—	—	—	—
Kingolwira Farm	226	237	153	232	141
Mvomero	485	430	385	394	396
Mkundi	389	414	373	360	355

YIELDS IN LB. OF LINT PER ACRE.

<i>Place.</i>	<i>M.U.8A.</i>	<i>B38/9.</i>	<i>B.P.52.</i>	<i>Local.</i>	<i>Mz.561.</i>
Ilonga	220	200	190	173	187
Mgera	145	134	92	97	89
Morogoro	239	189	195	184	177
Kingolwira Village	—	—	—	—	—
Kingolwira Farm	75	75	47	73	43
Mvomero	162	135	120	123	123
Mkundi	130	130	116	113	110

Insect attack was very variable over the whole series, but a combined analysis showed that M.U.8A and B38/9, except at Kingolwira Farm and Kingolwira Village, were significantly better in yield than Local. The complete failure at Kingolwira Village is not easily explained, the writer having been absent on leave when the crop matured. It may possibly be attributed to a low flowering rate accompanied by stainer attack, although the attack was moderate. The poor yield at Kingolwira Farm was undoubtedly due to these causes. The lower yields at Mgera, Mvomero and Mkundi were brought about by a combination of American bollworm and stainer.

The differential attack of American bollworm was again recorded, more larvae being found on M.U.8A than on the other varieties. The very much higher yields given by M.U.8A during the years 1943-1945 are not so marked this year. The variety has now been grown in close contact with poorer yielding types over a period of three years and a considerable amount of crossing with these types has taken place.

Strain Trials.—Trials of seven strains, five promising selections from Eastern Province Local together with B.P.52 and Local itself as a control, were carried out at Ilonga and on three of the district plots. These were laid out in randomised blocks with from 12-14 replications in each. On the total of 52 replications, G38/7, a selection from Local, consistently gave a considerably higher yield than Local. The results of small scale spinning tests at the Shirley Institute have already shown that this strain is as good as Local in quality. B.P.52, although of superior quality, is no better than Local in yield.

Single Plants.—A number of new selections and reselections from Local, made at Ilonga in 1945, were carried forward together with a number of special bulks. Reselections from the Barberton Sea Island $\times$ U4 crosses were also planted. Work on these had to be restricted owing to the writer's absence.

INSECT PESTS.

Continuous records of the main pests, together with plant development records, were taken as usual on the Variety Trials at Ilonga and on the district plots.

A census of the mature crop for stainer and bollworm damage was carried out.

Jassid (*Empoasca* spp.).—No damage of any importance was caused by this pest.

American bollworm (*Heliothis armigera*).—On three plots, Mgera, Mkundi and Mvomero, considerable damage was caused; the attack at Ilonga was moderate.

Shedding.—Ticketing of all flowers set on 200 plants of Local was again carried out at Ilonga. The shed flowers and bolls were examined for insect damage, as were also the mature bolls.

The results were :—

Total flowers set	...	...	...	...	...	2,197
Total flowers and bolls shed...	...	...	...	...	...	1,433

Of the total shed 28 per cent. was due to bollworm.

The open bolls were examined lock by lock, damage being classified into :—(i) Completely destroyed by bollworm; (ii) Completely destroyed by stainer; (iii) Grade III due to stainer, bollworm and *Helopeltis*; (iv) Grade I cotton.

Including shed bolls and flowers the final figures are as follows. The figures are percentages of the total flowers set.

Grade I cotton...	...	...	...	...	...	23.0
Total loss due to bollworm	...	...	...	...	...	29.6
Total loss due to stainer	...	...	...	...	...	5.7
Total loss due to other causes	...	...	...	...	...	28.2
Grade III cotton	...	...	...	...	...	6.1
Unaccounted for	...	...	...	...	...	7.4
						100.0

The loss due to bollworm was the same as in 1945. Stainer damage was appreciably less, owing to the fact that the attack was late and on a much smaller scale than in 1945.

Pink bollworm (*Platyedra gossypiella*).—Only a negligible number of larvæ were taken, towards the end of the season, on two of the district plots. No specimens were recorded at Ilonga. The uprooting date was altered in 1945 to make the close season a month longer, which may have caused this practical disappearance of the pest.

Spiny bollworm (*Earias* spp.).—This was recorded in all plots, throughout the season, but in much smaller numbers than in the previous year.

Stainers (*Dysdercus* spp.).—The usual four species, *D. intermedius*, *D. fasciatus*, *D. nigrofasciatus* and *D. cardinalis* were recorded.

The most important was again *D. intermedius*, but it occurred on a very much lower scale than in the previous season, a peak figure of 2,800 adults per acre comparing with 14,750 in 1945 at Mkundi. *D. fasciatus* was practically absent from three plots, occurring in some numbers at Morogoro and Kingolwira only. *D. nigrofasciatus* and *D. cardinalis* were observed only in small numbers.

Calidea spp.—This was taken in quite large numbers at Morogoro, but elsewhere was negligible.

Helopeltis spp.—Small numbers of this species were taken on all plots, but no damage of any importance was recorded.

Capsid (*Lygus* spp.).—No damage of any consequence from this pest was recorded during the season.

SUMMARY.

The season was much better than 1945 from the point of view of insect pests, stainers in particular. The crop was not heavy, as most cotton was late-planted owing to the weather. The sudden cessation of the rains in May undoubtedly also affected the setting of the crop.

PROGRAMME OF WORK FOR 1947.

The variety trial designed to test widely differing types, particularly with regard to their reaction to insect pests, has now been carried on for four years. It has given the information which was sought—that a high yielding type could continue to give high yields in spite of the insect pest situation. In view of this it will not be continued.

The strain trials and work with single plants will be continued. It is hoped to obtain species crosses from the Sudan for trial.

Routine simplified records of insect pests will be continued.

Clearing, surveying and draining of further land on Ilonga will be undertaken.

Two of the district plots, Kingolwira Farm and Kingolwira Village have now served their purpose, and will be abandoned. It is proposed to obtain two plots to replace them in the Kissaki area of Morogoro district, south of the Uluguru Mountains, an area which in the past has given good yields of cotton.

NYASALAND.
SEASON 1946-47.
COTTON EXPERIMENT STATION.

INTRODUCTORY NOTE

BY

H. C. DUCKER.

District.	Elevation.	Types of Crop.	Months in which :		Legal Close Season.
			Sown.	Harvested.	
Lower Shire } Lower River ...	200-500	{ Semi-summer Winter	Jan.-Feb. Mar.-Apr.	July-Oct. Sept.-Oct.	} Nov.-Dec.
Central Areas	1,000-2,500	{ Semi-summer Summer	Jan. Nov.-Dec.	July-Sept. May-Aug.	} Oct.-Nov.
North Nyasa : Karonga Lake shore areas only	1,600	Winter	Mar.-May	Sept.-Dec.	Jan.-Feb.

NOTE.—Close seasons in Nyasaland may be modified in future to accord with the entomological findings, when Government has decided what action to take in the Lower River. The question of extending the close season in the Central Areas to conform with the summer crop technique used at the Domira Bay Station, which is similar to that suggested for the Lower River should winter crop prove impracticable in that area, is also under consideration. Such an extension would mean up-rooting by July 31st, and would provide a close season of four months.

The reports by Mr. Griffin and Professor Debenham on the Shire River Barrage and Lower River Control and Irrigation schemes have not yet been published, but the Director of Agriculture has stated that a further and detailed survey will be necessary before Government can arrive at a decision regarding Lower River developments.

Meanwhile the Government are considering the possibility of carrying out a small-scale experiment to investigate the effects of summer cropping, as suggested as one of the alternative measures in the report on Red bollworm control compiled by Mr. Pearson and Mr. Mitchell. A note has been put forward by Mr. W. V. Rose of the Agricultural Department and Mr. S. T. Hoyle proposing that all cotton growing should cease for two or three years in an area contained in a circle having a 5-mile radius. The first non-cotton season should reduce the Red bollworm population to a low level. In the second and succeeding years cotton would be grown on small experimental plots at the centre of the circle and would there, it is hoped, be unattacked by bollworm.

Records of the pest incidence on the small experimental plots within the area will be made and Mr. Pearson has suggested that similar records be made on control areas outside the non-cotton circle. Such records, and yield comparisons, would give an excellent measure of the success or otherwise of the proposed mode of bollworm control.

The inherent agricultural circumstances of the country remain unchanged, but further increases in cotton prices have occurred, and it remains to be seen whether these will prove sufficiently attractive to potential growers in the Central Areas, where tobacco is still booming.

The 1946-47 rains in Nyasaland proved sufficient in amount but disappointing in distribution, and though the country did not suffer a disastrous drought like that which has afflicted Southern Rhodesia, it has been generally a rather poor season for annual crops and there is no surplus of food.

The difficult rains caused the Lower River cotton to be sown even later on an average than in 1945-46, but it seems that the crop is doing quite well, and production should not be less than it was last year. It is reported that about 75% was March sown.

Early flooding resulted in a loss of unpicked cotton in North Nyasa, a contingency which can only be avoided by the provision of irrigation facilities. These would enable the crop to be grown at safer levels on the alluvial fans. Another "high" lake caused the piece of land provisionally selected by the Agricultural Department for a district experimental station at Karonga to be flooded too deeply and too late for cotton planting this year. The variety trial planned for it has therefore been planted on the Kasisi plot, some five miles inland from Karonga. It is too early to say with what success.

It has not been a good year for the main experiment station, but there were no actual failures of crop, and the work has not been unduly hindered. The percentage of clean white seed cotton in the crop harvested was pleasingly high, and seed weights were good.

The station cereal crops were most affected by the season, and since there is a general shortage of maize in the Dowa area our food reserves for the labour need careful husbanding. Groundnuts and other pulses gave fair to good yields.

There were no staff changes during the year. The writer went on long leave in October, 1946, returning in March, 1947, in good time for the harvest. Mr. Hoyle left on long leave in August after the cotton harvest had been completed.

DOMIRA BAY STATION.

PROGRESS REPORT, 1946-47.

BY

H. C. DUCKER, S. T. HOYLE AND W. L. MILLER.

GENERAL SURVEY OF THE SEASON AND OF THE EXPERIMENTAL WORK ;
AND CONCLUSIONS.

METEOROLOGY.

The total rainfall for the season, November, 1946 to May, 1947, inclusive, was 39.39 inches, the second highest record to date at the Station. Like most wet seasons in the tropics, it was an unusual one.

It began with good planting rains in the middle of November, an exceedingly rare occurrence for this area, and, apart from two dry spells at the beginning of December and the middle of January, went on with more or less continual light showers, often amounting to little more than a drizzle, until the end of March. Such a distribution will have greatly replenished the underground water supplies—there was very little run-off—but was most unfavourable for crop growth and made weed destruction very difficult. There is evidence of the high percentage absorption in the fact that the main dam did not fill up, and that the Chitala stream near the Station, which normally dries up towards the end of April, was still flowing at the end of July. The amount of sunshine was considerably less than normal and this factor, combined with the continual rain, led to generally poor crop yields. By courtesy of the Southern Rhodesian Meteorological Service a sunshine recorder has been added to the range of instruments at the Station.

AGRICULTURE.

General.—The early rains enabled all the maize to be planted by November 21st, and the groundnuts by the end of the month. The latter, being planted toward the end of the first spell of rain, had to be supplied later when further rain fell. Cotton planting was begun on December 13th, about a week earlier than normal, and was completed in good conditions. Most of the cotton acreage was devoted to the breeding programme, and the few bulks planted were mainly on poorly drained black soil which never dried out properly. Weeding was very troublesome and was made more difficult by the shortage of labour, which made it impossible to complete all weed destruction in the two short dry spells. In addition, the attack of Red bollworm was greater than last year. All this resulted in exceptionally low bulk yields of 90–100 lb. lint per acre, though some better drained fields gave up to 180 lb. per acre.

Maintenance of Fertility.—The two resting crop experiments reported last year were continued. The first of these was designed to compare the values as resting covers of (1) elephant grass and (2) elephant grass plus velvet beans, and the second to test (1) elephant grass (2) pigeon pea (3) chance weeds and (4) perennial sorghum. After resting under these crops for three years, both experiments were test-cropped with cotton in 1945–46, and with maize in 1946–47. In both years no significant yield differences between the treatments were obtained, though this year the yield of maize after ratooned sorghum was less than that of maize following any of the other treatments. The type of rest crop employed is of great importance not only for restoring maximum fertility but also for ease of establishment and upkeep. A third factor, which will become of increasing importance, is the possibility of managing the resting crop with machinery. There is good reason for doubting whether the thickets of elephant grass can be cleared without the help of hand labour. A dwarf type of elephant grass, which may be easier to manage than

our local form, has been supplied to the Station by Mr. A. H. McKinsty of Gatooma, Southern Rhodesia ; but it may be necessary eventually to use a different species of grass.

A new experiment comparing various rest crops has been laid down this year, on land in the main rotation normally due for rest. The crops are as before : (a) sorghum as a perennial, the stand being supplied as proves necessary ; (b) chance weeds burnt each year ; (c) chance weeds protected from fire ; (d) pigeon pea degenerating to a weed cover as it dies out or is killed by termites, and (e) the normal station practice of elephant grass and pigeon pea. Straight planting of elephant grass has been omitted since it does better with a leguminous nurse crop. The layout consists of two five by five Latin squares which together fill a five acre field, which will be re-cleared for test cropping in 1951-52 season. The sorghum plots in the field chosen yielded 1,300 lb. grain per acre, as against 720 lb. grain per acre from the maize plots. The field was not badly run down, having given a good yield of groundnuts last season and a fair yield of maize in the previous year, and the very low maize yield must be ascribed to the difficult season.

In addition to the above experiment, three more long-term experiments have been laid down in consultation with the Department of Agriculture and with advice from the Statistical Department, Rothamsted. These will study further the problems of rest cropping, and also its relation with crop rotation. The layout of all the experiments is in the form of randomized blocks. Those experiments in which crop rotation is compared with continuous cropping of maize and cotton will have the main plots split to allow a simultaneous comparison of three methods of rest, chance weeds, elephant grass, and elephant grass with pigeon peas. This experiment is being started in two phases, one beginning with the resting periods, the other beginning with the cropping cycle.

The third experiment begun this year aims at ascertaining the best arrangement in "time" for the rest crop, and eight treatments are being used. These are two, three, four, five and six years' rest, with the three years' rest repeated four times in different arrangements with maize.

Mixed Cropping.—Two experiments were planted, one to find out the best intra-row spacing of maize to obtain the highest yield from very wide inter-row spacing, and the other to find out the optimum number of rows of cotton to grow between rows of maize. Unfortunately the fields chosen had black soil which, in a difficult season, became water-logged, and half of each experiment had to be abandoned. The other halves were harvested and gave yields rather higher than the average for this year. Owing perhaps to the small number of blocks available, the results were not significant, but the suggestion was that if maize is substituted for cotton in every fifth or possibly every fourth row, then the yield of cotton per acre is not reduced and the yield of maize comes as a bonus. There is also a suspicion that very close maize spacing (1 foot intra-row) reduces both maize and cotton yields even with a wide inter-row spacing for the cereal.

ROTATION CROPS.

Maize.—All the fields were planted exceptionally early ; growth was excellent at first, and a good crop was expected. But the lack of sun and frequent falls of rain, which never allowed the surface soil to dry out, caused a large proportion of the stems to be blind ; the average yield for the season was only 920 lb. grain per acre, though on some better drained fields of the red-brown soil type the yield was as much as 1,520 lb. per acre.

Groundnuts.—Only two varieties were planted, Gambia Bunch and Mwitunde semi-bunch, as foreshadowed in the 1946 report. This crop was not affected by the adverse season as much as the cotton and maize and the mean yield of 860 lb. nuts per acre was only 20% less than that of 1946.

TANKS AND DAMS.

An attempt is being made to complete the unfinished experimental dams, and the work is still in progress at the time of writing. Seepage into the sub-soil from the first and second dams is as before, and it is unlikely that the surface water of the main dam will last throughout the dry season, as it did last year for the first time. Vegetable growing on the seepage zone below the dams is proving quite successful, and it is intended to establish some orchard plantings round its margins. It appears highly probable that the build-up of ground water which is taking place below the dams and down hill from them will result in permanent water in the tank-dam which is being sunk below the seepage zone. Water has been struck at a depth of 6 feet 6 inches in this tank on a site where, before any dams were built, the table was at least 60 feet below the ground level, and the site is about 150 yards from the wall of the lower dam. An obvious advantage of water stored underground is its relative immunity from evaporation losses. These are very severe with an open-water surface.

SOIL STRUCTURE STUDIES.

A large number of estimations of "crumb structure," using the technique developed by Dr. W. S. Martin of Uganda, were made in April, May and June, after the heavy rains had ceased. Samples were taken from the two main soil types of the Station, from fields at different stages of cultivation, and from bush land which has lain long undisturbed. In the case of the latter samples were taken from below various species of grasses common in this area, specimens of which have been sent for identification.

In general the reddish-brown soil showed poorer "crumb" content and higher "gravel" content than the black soil of the Station. "Crumb" structure in both soils appears to be easily reduced by cultivation, and in the case of the black soil is almost completely destroyed by water-logging.

A lower general order of values was obtained with both soils than their clay content would have indicated. Figures of "true crumb"

ranged from 34%-45% for the black soil and 18%-30% for the red soil, with land rested for four years under elephant grass in each case. The "gravel" figures were respectively 10%-11% and 23%-26%.

It is thought that the "gravel" content of these soils is a critical factor since the presence of "Sekera" grass (*Hypparrhenia* sp.) appeared to be correlated with high "gravel" content rather than with good "crumb." The "end point" in sifting the reddish-brown soils was rendered difficult of definition by what appeared to be the abrasive action of "gravel."

COTTON BREEDING.

Variety Trials.—The same varieties were used in trials at the Cotton Experiment Station, at Sharpevale in the Central Areas, and at Mafumbe on the Lower River. The figures for the last named are not available at the time of writing (September).

At the Cotton Station the trial was repeated at three different dates of planting, as since much of the native crop is planted after the optimum time it is important to find out if any variety will out-yield others when mishandled in this fashion. Ordinary times of planting experiments are not reliable in this country owing to the build-up of pests in the later plantings, so in an effort to overcome this difficulty the three trials were planted as isolated from each other and from other cotton as conditions allowed. The last time of planting, on January 13th, happened to coincide with the start of a dry spell. Germination did not begin for a fortnight, and was then so patchy that the trial had to be abandoned. The results from the other trials, together with those from Sharpevale, and the mean corrected lea products from the trials grown in 1946 at the Station, Sharpevale, and Mafumbe, are given in the table below:—

Variety.	C.E.S.	C.E.S.	Sharpevale.	Lea Products at 40s.
Planting Dates.	14/12/46	28/12/46	7/12/46	
	<i>lb. Lint per acre.</i>			
C.L.20-30	151	189	197	2,287*
C.L.20-34	152	158	216	2,153
C.L.20-46	170	184	208	2,180
B.181	155	175	185	2,413
T.22	151	190	183	2,292
C.L. Bulk (Control)	144	194	205	2,192
Sig. Diff., P. = 0.05	12.5	20	15.4	—

* Cotton Station only.

It was rather surprising that the first time of planting at the Cotton Station should have given a lower yield than the second. This may have been due to the fact that the soil of the field used for the latter is better drained and so the plants suffered less from the adverse weather conditions, but tagging records showed that the later time of planting had 10% less bollworm loss which can account for over 50% of the difference in yields.

All these strains and varieties are capable of giving good yields of satisfactory quality when they have the chance, including the unselected Crown Land Bulk which is the commercial seed stock of Nyasaland. It appears that this and the selections from it do rather better than the other varieties when conditions are not quite so good; a matter, probably, of adaptation.

The spinning quality is satisfactory throughout, with the Mz.561 derivative, T.22, rather better than the Crown Land stocks. B.181 gives stronger yarn than any of the others due, apparently, to its low hair weight, since its lint length is on the short side.

Breeding Material.—Some 900 single plant selections were planted in four-fold replication. This was done because it has been found that the influence of the site and local environment is so great that genetic factors are easily obscured, and little reliance can be placed on the appearance of a single plant.

C.L.20.—There were 600 single plant progenies in this stock, of which 120 have been selected for further trial. The lint from each of the reselections has been sent by air to the Shirley Institute for small-scale spinning tests, and five to ten single plants taken from each. A further reselection will be made, based on the result of the spinning tests, which should be received well before planting time arrives. There was evidence of a good deal of variation in yielding capacity, and it is hoped that some of the good croppers will combine high yield with good spinning quality.

T.22.—The spinning tests last year showed that five of the twenty-five progenies of this derivative from Mz.561 were outstanding for yarn strength, and progenies from these five only were planted this year. Twenty-four of the 1946 progenies were planted in a 5×5 balanced Lattice square trial with T.22 bulk as control. Two-thirds of the sub-strains yielded better than bulk, and among them were two of the five good spinners. Further selections were confined to these two sub-strains.

B.181.—Two hundred progenies were planted and they had a remarkably even appearance in the field, though there were larger differences in their lint length. Eventually thirty lots combining good lint and good field characters were taken for further work. They were, however, so very even in type that it seems unlikely that a sub-strain yielding higher than the bulk will be isolated. The most hopeful future for this variety, combining as it does a number of very useful characters, seems to be as a parent of new crosses in Nyasaland.

Crosses.—No new crosses were made this year, but two were imported from Mr. J. D. Jameson in Uganda, to whom the Station is greatly indebted for these and other stocks. The new introductions were B.C.66, a B.P.52 $\times$ B.181 back-cross, and H.78, a cross between B.P.52 and N.17. Both did quite well in observation plots sown in duplicate, and they contain some very nice lint.

H.69, the B.P.50 $\times$ B.181 cross supplied by Mr. Jameson last year and grown as a progeny row in the garden, did better this year under field conditions than its previous performance would have indicated. The eight crosses made last year with B.181 were grown as large F₁s and made a very promising showing.

It is intended to compare all this cross-bred material for yielding power in F_2 , and thereafter to concentrate on the highest yielders. A range of single plant selections was taken from the Uganda crosses, and self and natural bulks of all crosses, including A.2208 the M.U.8 $\times$ U.4 cross from Barberton, are available for the 1947-48 season. The latter, the only survivor of the Barberton "quality" crosses, made a moderate showing in observation bulks.

New Introductions.—In addition to the crosses mentioned above, a number of new introductions were grown in observation plots. They included a range of Brazilian material obtained by the Corporation by kind courtesy of Mr. Munro Kerr (Messrs. J. and P. Coats) comprising various forms of Moco, Verdao, and Rim de Boi. These Brazilian varieties were planted in observation plots and rigorously rogued for jassid susceptibility, and later all early flowering types were discarded, except for a little Verdao retained as single plant selections. The balance remaining were all truly late types, but it seems unlikely that as they stand they will be of any commercial value in this country. They may, however, prove useful as cross-breeding material.

Other new introductions were kindly supplied by Mr. J. B. Hutchinson, and included the two Indore cottons M.U.8A and M.U.8B. The Station is also indebted to Dr. R. L. Knight for blackarm-resistant and susceptible forms of S.P.84 and B.P.52 referred to in more detail later, under blackarm.

PESTS AND DISEASES.

Flower taggings were made on each of three varieties in the first and second times of planting of strain trials, using a technique similar to that of previous years.

T.22 produced about the same number of flowers in each trial but C.L.20-46 and B.181 gave approximately 45% more flowers in the second and higher-yielding trial. T.22 was a little earlier, but apart from these two differences there was little to choose between the varieties. The mean figures for the two trials were as follows:—

[illegible]

The loss due to bollworm was three or four times as high as last year. The total acreage under cotton was reduced from over 85 acres to about 70 acres this year and some increase in loss due to a concentration effect was therefore certain. But the four-fold increase with the first time of planting was higher than expectation and may be due to the time of planting. The fact that the district cotton crop was uprooted somewhat later than usual may also have had some effect.

An attempt was made to control Red bollworm (*Diparopsis castanea*) on small areas by means of a 5% D.D.T. dust. Two plots were dusted once weekly, or more frequently if heavy rain intervened. The shed squares and bolls were collected and compared with the number collected from neighbouring control plots of similar size. Altogether the plots were dusted 13 times between February 28th and May 9th. There was no evidence of any control. Sheddings were at the same rate from the controls and from the dusted plots, and though the powder seemed to remain on the plants well after light showers, it was concluded that this method would be useless.

Blackarm.—The studies begun last year were continued. Inoculum was made up and plants sprayed, using Dr. R. L. Knight's technique. A large number of local strains and varieties, and the two resistant and two susceptible varieties, supplied by him and referred to earlier, were sprayed. The results were disappointing as the differences expected did not show up even between strains known to be susceptible and resistant, and the development of lesions was slow. No really black lesion was found. The highest grade seen was No.8, and that was a doubtful specimen, while the great majority of leaves graded between 4 and 6. The fully susceptible varieties were graded at 5-6 and the resistant ones at 4 or thereabouts. Independent counts by two of us gave similar results, and it was concluded that there must be some factor present in Nyasaland which inhibits the development of lesions as seen in the Sudan. Although blackarm lesions are commonly found in the field here, the disease does not appear to be a limiting factor in crop production.

A test will, however, be made of the comparative yielding power of the resistant and susceptible varieties from the Sudan. All four gave fair yields in observation plots, which were used in the spraying tests. Their Sudan numberings are BAR.7/1, BAR.12/1, SUS.7/2 and SUS.12/2.

GINNING.

In order to provide some experimental material for the Shirley Institute, and to obtain further information about the relative efficiency of various machines at the Cotton Station, a range of commercial samples kindly collected for us by Mr. Cormack of the Department of Agriculture was divided into two series and ginned on a 12-inch roller and a 16-saw gin respectively. Both machines were power driven.

The Institute reports that in each case the yarn from the roller-ginned sample was better in appearance than that from the saw-ginned sample. In each case also the roller-ginned sample gave stronger yarn.

The old saw gin at the Station has now been scrapped and replaced with a new 16-saw gin. Samples of one lot of strain trial material have been ginned, some on this and some on the 12-inch roller, and have been sent to the Shirley Institute for test. The results are awaited with interest.

SUMMARY OF MAIN CONCLUSIONS.

1. The possible advantages of an early start to the rains were nullified by continuously wet and sunless weather, and it is probable that the crops suffered from nitrogen starvation. The poor yield of cotton and even poorer yield of maize, compared with the relatively good return from groundnuts, are suggestive.
2. Sorghum suffers less than maize in a poor season, and in addition to having possibilities as a rest crop merits more consideration as a food producer on the station than it has been given to date.
3. Mixed cropping of cotton and maize gave inconclusive results, but more investigation is justified.
4. Soil "crumb" structure studies have been begun, and it is suggested that the Station soils may exhibit some specialised features.
5. Cotton work has proceeded on familiar lines, and the "sifting" of our main varieties has made good progress. Trials show that the present commercial bulk cotton is still capable of good yields and satisfactory lint quality.
6. Attempts to control Red bollworm with D.D.T. 5% dust have not proved successful. There was more bollworm loss this year.
7. Blackarm (*X. malvacearum*) does not appear to be a limiting factor under the conditions of the past season, but a direct comparison between the yielding power of susceptible and resistant types of the same parentage will be made next season.

PROGRAMME OF EXPERIMENTS, SEASON 1947-48.

Variety Trials.—The Station and District trials will be continued. At the former, the greater part of the experiments will consist of balanced lattice squares comparing the "sifted" varieties and plant-breeding material.

Selection.—Work will be continued on T.22, C.L.20 and B.181 stocks, and the new Uganda crosses.

Hybridization.—Work will be continued on the local crosses and begun on those made by Mr. J. B. Hutchinson at Shambat. Work on the latter had, unfortunately, to be postponed one season.

Mixed cropping.—The 1946-47 experiments will be repeated.

Maintenance of fertility.—The unfinished experiments will be continued, and certain new rest cropping experiments begun. The latter also involve rotation experiments.

Blackarm.—Field tests for yielding power of susceptible and resistant types will be made.

Soil Structure.—Studies to be continued.

[Included by courtesy of the Nigerian Government.]

NIGERIA.

PROGRESS REPORT ON COTTON GROWING IN THE NORTHERN PROVINCES FOR THE SEASON 1946-47.

Normal Planting dates Mid-June to end of July.
Normal Picking dates December to February.

SUMMARY.

Rainfall during the year was good for cotton growing but Pink bollworm (*Platyedra*) is now a recognised pest in Northern Nigeria and may have caused some damage. Yields on the experimental farm were normal.

Strain Samaru 26c was multiplied up at Daudawa. It has given satisfactory results and was distributed to farmers for the first time in 1947. The area chosen for this distribution is that in the immediate vicinity of Daudawa. This is a change in policy, as previously seed from Daudawa Stage II was sent to farmers in the Awai district.

A mulching trial was carried out but no increase in yield was gained by mulching.

Topping caused a significant reduction in yield.

Variety trials were carried out at Daudawa and on the school farm at Samaru. No significant differences were obtained.

FIBRE REPORTS ON 1945 EXPERIMENTS.

Experiment W1 (45) at Daudawa.

Samples of three strains grown at Daudawa were sent to Shirley Institute, namely, "Daudawa 45" (Samaru 26c), Commercial Allen ex Mai Inchi ginnery and as control Commercial Allen ex Funtua ginnery. The report of Shirley Institute on these was "Daudawa 45 was slightly shorter and appreciably coarser than the two samples of Allen which were very similar to each other in measured fibre characters. The yarns of the three samples were very similar to each other in strength; on the whole those from Daudawa 45 (26c) were rather better in appearance than those from Allen."

Seed from Mai Inchi ginnery was included because it had been decided to discard all seed from Mai Inchi ginnery and to replace it with seed from Funtua ginnery. This is a normal procedure practised

every few years because it is thought that the strain "degenerates" when grown at Mai Inchi for a few years. The discarded seed was included in the trial to test whether the seed had "degenerated" or whether the poor quality of the crop at Mai Inchi was due merely to climatic and soil conditions and not to poor seed. In both quality and yield the Mai Inchi seed seemed to be as good as the seed from Funtua ginnery when grown in the more typical cotton-growing area at Daudawa, so there were no facts to support any theory of "degeneration."

Experiment A11 (45).

Samples of all the nine strains in this trial were sent for analysis and Shirley Institute summarised the results as follows :

"The strongest yarns were given by N'Kourala and Allen with 26C, 26G and 26I next ; 26E was weakest. In appearance yarns from 26C and 26I were best. Oasis and Allen gave the most neppy yarns. On the whole N'Kourala was the best sample of this group, Allen was equally strong but more neppy, whilst 26I was somewhat weaker but better in appearance. Differences in length and maturity were not great. Fibre weight showed more variation, lower values of standard fibre weight being given by 26I, 26E, 26H, Oasis, Allen and 26G than by others."

Samaru 26C was thus coarser than Allen, the standard hair weights being 222 and 209 respectively. It was weaker, the highest standard count being 36 compared with 42 for Allen, yet it had a brokers' valuation of 19.75 compared with 19.45 for Allen.

Experiment A6 (45).

Samples from plots with different amounts of potash were sent, but there was little difference and no general trend.

Experiment A13 (45).

Shirley Institute reported that the mulched sample gave slightly higher effective length and was also slightly stronger and better in appearance. However, the differences were small and as the differences in yield were not significant it was not considered that mulching had had much effect on this occasion.

FIELD REPORTS ON 1946 EXPERIMENTS.

Experiment W1 (46) at Daudawa.

A latin square variety trial.

Differences, unfortunately, were not significant and average yields in lb. lint per acre were as below :—

Strain.	Gin %.	lb. per acre (lint).	% of Allen.
Daudawa 44	31.5	119	125
N'Kourala	31.0	102	107
26i	32.5	100	104
26E	31.7	98	102
Daudawa 45	29.2	96	100
Comm. Allen	29.4	95	100
Oasis	29.3	95	99

The Daudawa 45 was pure Samaru 26C which had been grown in Stage I of the multiplication scheme in 1945 and will pass to Stage III in 1947. N'Kourala is a strain introduced from Belgian Congo. Very closely related to 26C are 26E and 26I which are very pure lines and are selections from Allen.

Although the differences were not significant the yield of Daudawa 45 was very disappointing. The low yield was mainly due to the exceptionally low ginning percentage obtained. The same seed, however, was grown in Stage II at Daudawa and when ginned at the commercial ginnery Funtua it gave a ginning percentage of 38 which was the highest on record.

Experiment A6 (46) on Botanist's Farm at Samaru.

This was an experiment to test the effect of topping on yield.

Layout randomised block, 8 repeats, plots 1/100 acre, manure 2 tons per acre, spacing 3 ft × 18 ins., sown 2/7/46.

Treatments were :—

- (1) Control.
- (2) Main stem topped 4/8/46 (height approx. 1 ft.).
- (3) Main stem topped 3/9/46 (height approx. 2 ft.).
- (4) Main stem cut back to 1 ft. on 26/9/46 (height approx. 3 ft.).

Yields in lb. lint per acre were :—

	Gin %.
Control = 218 lb.	35
Top 1 ft. = 180 "	33
" 2 " = 173 "	32
" 3 " = 134 "	33
S.E. = ± 11.45 lb.	
5% Sig. Diff. = 34 lb.	
1% " " = 46 "	

The control plots were thus significantly better than all others.

Experiment A6 (46) on Botanist's Farm at Samaru.

This was a trial to see if mulching the land had any effect on yield.

Randomised block, 7 repeats, sown 29/6/46, harvested 6/12/46, spaced 3 ft. × 1½ ft., manure 2 tons per acre.

Summary of yields :—

Control	= 210 lb. lint per acre.
Mulched after last rain in October	= 189 „ „ „ „
„ middle September	= 179 „ „ „ „
Differences were not significant.	

Experiment H2 (46) on School Farm, Samaru.

A variety trial, balanced lattice, plots 1/36 acre, sown 27/6/46, harvested 27/11/46.

The differences were not significant and the yields are summarised below :—

	lb. per acre.		Gin %.
	Seed Cotton.	Lint.	
26c	601	198	33
26E	639	238	37
26F	594	213	36
26G	597	233	39
26H	685	244	36
26I	618	245	40
N'Kourala	632	191	30
Oasis	649	207	32
Comm. Allen	655	187	28

Experiment S1 (46) at Samaru.

A factorial experiment combining dates of sowing, spacing and number of plants per stand.

Yields of Seed Cotton per Acre (lb.)

Dates (D).	Spacing (S).	Plants per Stand (P).
July 4 ... 565.1	15 ins. ... 480.6	2 plants ... 460.6
„ 25 ... 563.7	9 ins. ... 445.8	3 „ ... 454.2
Aug. 5 ... 432.8	21 ins. ... 436.2	4 „ ... 447.9
Sept. 15 ... 253.6		
S.E. ... ± 46.2	± 7.35	Not Significant.
5% Sig. Diff. 207.8	31.8	

Interaction—Spacing by Plants.

Spacing.	Number of Plants per stand.			aver.
	2	3	4	
9 ins.	494.1	416.2	427.2	445.8
15 „	464.1	508.7	468.9	480.6
21 „	423.5	437.7	447.8	436.3
Average	460.6	454.2	447.9	

S.E. (S. sub plots) = ± 19.1
5% Sig. Diff. = 55.1 lb. per acre.

Conclusions.

Planting on September 15 gave a significant reduction in yield. Although the differences between cotton planted July 4, July 25 and

August 5 were not significant there was a trend towards higher yields with earlier planting. Spacing at 15 inches proved to be the best, regardless of the date of planting, and when planted at 15 inches the best yield was obtained by leaving three plants per stand.

PROGRAMME OF WORK FOR 1947-48.

No enlarged programme is contemplated owing to lack of specialist staff. Variety trials will be continued.

PROGRESS REPORT ON WORK ON COTTON IN THE WESTERN PROVINCES OF SOUTHERN NIGERIA FOR THE SEASON 1946-47.

Normal Planting dates... .. First 3 weeks of July.

Normal Picking dates January to February.

Botanical work at Ibadan followed the same programme of selection and multiplication of Ishan A as in previous years but was rendered extremely difficult through failure of the normal rains. Planting was done on 17th July, and the plots had to be watered at intervals thereafter in order to prevent complete failure. In the following table the rainfall figures for the four months of July to October are compared with the mean rainfall over the same period in the preceding five years:—

RAINFALL IN INCHES.			
		1946	Mean : 1941-45.
July	...	0.29	5.57
August	...	0.61	2.50
September	...	3.45	6.72
October	...	7.56	6.28
		11.91 inches	21.07 inches.

The exceptionally dry conditions combined with insect attack had a disastrous effect on yield. Attack by *Helopeltis* and leaf-roller was severe, though kept down so far as possible by hand-picking. A few plants showed leaf-curl and were removed. Damage by Pink bollworm was severe, causing a loss of about 60% of the seed produced. The final yield of seed-cotton was at the level of 90 lb. per acre as against the normal yield in these plots of 400 lb. per acre.

Selection.—The self-pollinated seedlings of 16 plants, selected from the highest yielding selection of the previous season, were grown in progeny rows of 40 plants each, spaced 5 feet apart on ridges at intervals of 6 feet. Plants were selfed and 8 rows were chosen for their halo length and ginning percentage to provide seed for continued selection in 1947. Mean halo length and ginning outturn figures

are given below for the 16 progeny rows, of which the first 8 were retained for further selection work :

<i>Progeny Row.</i>	<i>Ginning Outturn.</i>	<i>Halo Length. (mms.)</i>
A1	37.2	29.1
2	36.2	30.2
3	37.4	29.1
5	36.6	30.7
6	36.2	30.7
8	36.6	29.9
10	36.6	29.6
13	36.0	30.1
A4	36.6	27.4
7	36.4	29.2
9	35.8	28.5
11	35.2	30.9
12	35.8	28.8
14	35.6	28.7
15	35.8	29.3
16	36.2	29.0
Mean	36.3	29.4

Multiplication.—The balance of seed from the 1945 yield trial was used in a multiplication plot. This was planted in the form of a spacing trial to test the effect of distance of planting on yield. Owing to the poorness of the crop at all spacings no significant difference resulted.

WEST INDIES.

COTTON EXPERIMENT STATIONS.

INTRODUCTORY NOTE

BY

J. V. LOCHRIE.

A picture of the general conditions of West Indian agriculture has been compiled by Sir Harold Tempany (1), and the agricultural problems of the West Indian cotton industry outlined by J. B. Hutchinson (2). The cotton-growing islands differ in soils, topography, rainfall and economic conditions, but they have problems in common—the need for soil conservation measures; for suitable farming systems to maintain and increase soil fertility; and for an intensification of production to meet the needs of expanding populations.

ANTIGUA.

This is the first report from the Cotton Station and the following note outlines the agricultural conditions in relation to the cotton crop.

Inherent circumstances.—Antigua is less mountainous than the other cotton-growing islands and the mainstay of the economy is sugar. It does, however, present problems of steep slopes and consequent erosion and the expanding demand for land will increasingly bring these slopes under cultivation.

There are three main topographical zones (a) an area of rolling limestone country to the north and east with rounded hills and intervening valleys flat to gently sloping; (b) a central plain of undulating country and (c) a mountainous volcanic area to the south and west. The soils have been described by Charter (3). The soils of the limestone area have been developed from compacted marls and are grey to black clays lightened by a high admixture of calcareous sand. They are often of fair depth in the valleys and progressively lighter towards the hills. The reaction is highly alkaline and the high proportion of calcareous sand makes them easily worked and drainage is fairly good. This is the main crop area with sugar occupying the best valley land and cotton on the thinner hill soils and in areas marginal for cane on account of low rainfall and transport difficulties. The central plain varies greatly in fertility but in general the soils are heavy clays of poor natural drainage, alkaline in reaction and often thin. Most is rough grazing, but in the south-east the soils are somewhat lighter and better drained and cotton is grown. In the south and west the soils are of volcanic origin and vary from light sandy loams to heavy clays of reasonable fertility and fair depth in the valleys. Most of

(1) "Agriculture in the West Indies" Colonial No. 182.
 (2) Progress Reports from Experiment Stations. Season 1943-44.
 (3) "Soil Survey of Antigua" by C. F. Charter.

the area is suited only to forest growth and rough grazing while sugar cane is grown in the larger and more accessible valleys. Peasant food crops dominate the remainder and the area at present contributes little to the cotton acreage.

In common with the other islands the climate is that of the insular tropics, with average maxima and minima of around 80° and 72° , while the difference in temperature between the hottest months—May to November—and the coolest—January to April—is slight. Antigua is drier than the others with an average rainfall of 44 inches, varying from 33 inches in the east and north to 45 inches in the centre and over 50 inches in the south-west. The rainy season is from July to December and the dry period is often long and severe. In common with the West Indies generally, there is considerable annual variation and the rainstorms of high intensity and periods of drought which occur stress the need for suitable systems of soil and water conservation.

Agricultural System.—Cotton is grown on a few estates but has become increasingly a peasant crop, grown to some extent on his own land but mainly on land rented from year to year. Generally there is no system beyond continuous cropping with some period of rest where available land makes this possible. The crop is unmanured and rotation is little practised. Land purchased by Government has been allocated under a leasehold system and improvements may be looked for as a result of the increased security of tenure and the supervision and instruction given to settlers. Soil conservation measures have been carried out on the settlements and on some land outside but it cannot be said that any real soil consciousness has been awakened in the cultivator. Cattle and small stock are kept but stock-keeping has not been built into the farming system. The animals are grazed on whatever rough grazing occurs, and the manure seldom finds its way to the arable land. The peasant's economy centres round his cash crop, whether cane or cotton, and there is no self-sufficiency in food crops. Maize, sweet potatoes, cassava and yams with small amounts of pulses are grown, but in no way constitute a rotation system.

Practices.—As in the other islands peasant cultivation is by hand and too often preparation of the land and subsequent planting and weeding are unduly delayed with resulting loss of yield. Planting is mainly on ridges across the slope but some flat planting occurs in the drier areas. The usual spacing is 2 feet apart on 4 feet ridges, stands are satisfactory but in more difficult conditions the low seed rate often used results in poor stands and extensive supplying. The crop is generally grown in pure stand but may be intercropped with maize. The planting season now starts in late August and is restricted by law to two months. A close season of three months is enforced.

Economics.—Where soil, climatic or other conditions are marginal for cane growing the cultivation of cotton is considerable but both in acreage and in yield there are wide fluctuations. In the 1930's the acreage dropped to a few hundred and rose to the peak of over 4,000

in the early war years ; it has since dropped again. The average yield over a long period has been 120 lb. lint per acre and over the past 3 years 200 lb., with the record high level of weather conditions and a remarkable freedom from pests. The crop plays an important, if relatively small, part in the economy of the island but its extent is determined by the success of the preceding crop and the price offered.

Pests.—The main pest is Pink bollworm (*Platyedra gossypiella*) and the success of the crop depends on the efficiency of the control measures. A close season of 3 months is proclaimed each year and its strict enforcement is of the highest importance. Apart from growing cotton plants the pest may be carried over as long-term larvæ in buildings where cotton has been stored. As far as ginneries and commercial stores are concerned, the practice of disinfecting the premises with D.D.T. spray or Gammexane smoke generators is being adopted and should reduce re-infestation from this source. Peasant dwellings where cotton is stored and sorted present a problem, as small lots of stained cotton may be held over. Attempts are being made to improve this by making it more remunerative to sell such cotton and by propaganda on the danger of its retention.

The cotton leaf worm (*Alabama argillacea*) may be serious but adequate supplies of poison are maintained and the damage can be minimized by prompt and efficient spraying of the crop with lead arsenate.

Cotton stainer (*Dysdercus sp.*) has at times been a considerable source of crop loss but of recent years damage has not been heavy. The green bug (*Nezara viridula*) has not been recorded as a serious pest of cotton, but experience on the Station in the present season indicates that it may have considerable effect in some seasons.

Seed supply.—In common with the rest of the Leeward Islands Antigua grows the M.S.I. strain. Pedigree seed is received annually from the Cotton Breeding Station in Montserrat and bulked under the control of the Department of Agriculture. Under the multiplication scheme no seed for the commercial crop is more than four generations from the breeding plot and much of it only three.

The spinning quality of M.S.I. cotton grown in Antigua is somewhat lower than that of the same strain in Montserrat and St. Kitts but the particular environmental causes of this lower yarn strength and slightly coarser fibre are not clear.

ST. VINCENT. CAMDEN PARK EXPERIMENT STATION.

With the transfer of the Empire Cotton Growing Corporation's plant breeder, Mr. H. L. Manning, the cotton breeding and seed supply programme devolved on the Department of Agriculture. The new Camden Park Station has been established to investigate general agricultural problems as well as those specific to the cotton crop. The change over and the broader basis of the investigational work made reduction in cotton breeding necessary but the work of maintaining the superfine V.135 strain at a high level continues on the same

lines as before. Details of the breeding and seed supply are given in the present Report.

The V.135 strain is a "good land" cotton and the low variance in the material affords no scope for yield response by further selection. Comparative trials have demonstrated that the big boll M.S.I. strain is a better yielder, especially on the poorer land classes, and a long term breeding programme was started with the object of combining the superfine quality of V.135 and the high agricultural value of M.S.I. The excellent progress made by selection in this V.H. hybrid material has been described in earlier reports. The programme has been simplified by confining selection work to derivatives of high spinning value. The present report shows the higher yielding character of the V.H. strains compared with V.135, while the indications from spinning test data show that some of the material is in the V.135 superfine class. Comparative trials on poorer soils are important and are proposed for the coming season.

The average yield over a number of years is 115 lb. lint per acre. The low average, and the fact that the peasant crop commonly gives less than half the yield of estate grown cotton, indicates the prospects of betterment from improved farming systems and practices. The crop is planted during the wet season and, in these circumstances, fertilizer trials have shown nitrogen to be the main factor in increasing growth and yield. Further work is proposed both with manurial and rotation trials.

MONTSERRAT. COTTON BREEDING STATION.

Cotton is the main crop and constitutes almost the entire source of revenue from the land. A part of the crop is grown on estate lines but much is cultivated by peasants on the share system or on rented land. The broken topography of the island and the cultivation of a crop liable to accelerate erosion, together with the lack of any return to the land, have resulted in serious soil impoverishment in some areas.

Breeding work on the M.S.I. strain has been one of the main duties of the Station. The strain is now very uniform and selection work is confined to maintaining the purity and quality of the strain and to providing nucleus seed stocks to the other islands growing M.S.I.

A fair amount of work has already been recorded on the fertilizer needs of the various soil types and the indications are that the nitrogen level is of foremost importance though phosphate may be valuable particularly on the Shoal soils with impeded drainage. The crop is planted in the dry season and establishment is often difficult. The present season offers an example, as the dry and patchy conditions spread the planting season over 3 months and resulted in a low production and in the failure of field trials.

Some estates rest the land periodically under a green manure crop but in general no rotation system is practised. The rotation trials now started should provide useful information on land use.

COTTON EXPERIMENT STATION, ANTIGUA.

PROGRESS REPORT FOR THE SEASON 1946-47

BY

J. V. LOCHRIE.

GENERAL NOTE ON THE SEASON AND THE DEVELOPMENT OF THE STATION.

					<i>Commercial Crop.</i>	<i>Station Crop.</i>
Planting period	...	...	...	1st Sept. to 31st Oct.	...	Early September.
Picking period	...	...	...	January to May	...	January to March.
Close season	...	...	...	31st May to 31st August	...	—

Antigua was selected as a suitable site for the Station as it is the centre of Government of the Leeward Islands colony in which about three-quarters of the Sea Island crop is grown. Air and sea transport facilities are good and it is a useful centre for the advisory duties of the Cotton Officer and for maintaining contact with the work being carried out in the other islands.

Development work was started early in 1946 on an area of 35 acres granted by Government for use as a Cotton Station. The land is part of the Agricultural Experiment Station of the Antigua Government and the arrangement has obvious advantages in close contact with officers of the Department and in economy of equipment. I have to acknowledge with real appreciation the advice and the facilities given me during the period of selecting a site for the Station and of subsequent building and development.

At the beginning of the season Mr. J. R. Spence was appointed to the Station. Much of the time was taken up in development work on buildings and fences, in laying out the area in suitable soil conservation systems, and in establishing the layouts for rotation and other experiments.

The Station is situated on the limestone area and is typical of an extensive area of the cultivated land of the island. It consists mainly of gently sloping valley soil with some steeper hill land up to 30 per cent. slope. The soil is a grey to black crumbly clay developed from argillaceous marl containing limestone fragments and overlying limestone at varying depths depending on proximity to the hills. The natural drainage is fair and the soils are easy working. On the steep slopes the topsoil and the parent marl is thinner and contains stones. These lighter soils are being increasingly brought under cultivation by peasants and it is of importance that information be obtained on suitable soil conservation methods and cropping systems. The varied topography of the Station affords opportunity of investigating methods of conservation and of soil fertility maintenance.

Samples from soil profiles and from the topsoil of all sites of experiments have been examined by Professor Hardy of the Imperial College of Tropical Agriculture. The Station soils are described as Rendzina, highly calcareous in all layers. They are heavy clays but lightened by admixture with calcareous sand, and this limestone contamination has imparted high alkalinity (PH8.2) to the topsoil. Organic matter and nitrogen content are fairly high but, as nitrifying efficiency is low on Rendzina soils, a relatively small amount of nitrogen may be available. Available potash is reasonably high but pot tests on similar soils indicate definite phosphate deficiency despite a fairly high Truog value.*

METEOROLOGY.

As this is the first report from the Station a table is given below to indicate the rainfall in the area during the past 30 years. The year is taken from the beginning of the close season as the rainfall during the close season months will presumably influence the carry-over of long-term Pink bollworm larvæ in cotton debris in the open.

(A) is the wettest year; (B) the driest; (C) the average over the whole period; and (D) the rainfall in the present season.

		June, inches.	July, inches.	Aug., inches.	Sept., inches.	Oct., inches.	Nov., inches.	Dec., inches.	Jan., inches.	Feb., inches.	Mar., inches.	Apr., inches.	May, inches.	Total, inches.
A ...	...	4.11	5.09	5.68	6.07	3.16	6.90	3.19	9.61	3.11	0.80	6.76	2.63	57.11
B ...	...	1.83	2.27	2.43	1.01	2.83	6.94	1.34	0.69	0.78	1.57	1.47	3.39	26.55
C ...	...	3.82	3.74	4.43	4.77	5.22	5.35	2.86	2.38	1.62	1.54	2.04	3.27	41.04
D ...	...	1.49	1.71	3.51	4.71	4.33	5.57	4.23	4.15	0.60	0.82	0.80	3.53	35.45

The Station crop was planted in early September and conditions for germination and early establishment of the crop were excellent. In the other cotton-growing areas September rains were good but October gave less than 2 inches. Much of the peasant crop is habitually late planted and where the September rains were missed the crop was considerably delayed and yielded poorly in the short season. On the Station conditions were satisfactory and growth and development were good but the season was short owing to the abrupt end of the rains in late January. A severe attack of *Nezara* caused substantial loss of early crop but the main cause of lowered yield and the comparative failure of the experiments was the early and heavy infestation by Pink bollworm.

AGRICULTURE.

Considerable field experimentation has been carried out on sugar cane, and the use of artificials and of such pen manure as is available is common practice on sugar estates. Little is known of the requirements of the soils for cotton growing and the crop is typically unmanured.

Fertilizer Trials.—A series of factorial experiments using three levels of N.P.K. were laid out on the Station and on other representative cotton soils. The range of application was fairly wide; up to 400 lb. sulphate of ammonia; 600 lb. superphosphate; and 300 lb. sulphate of potash.

* The Phosphate requirements of calcareous soils. (F. Hardy and others.) Tropical Agriculture, 1938, XV, pp. 183—186.

The Station trial was planted on September 4th and established well with excellent stands. Growth and development were good but infestation by *Nezara* and Pink bollworm was early and severe. The season was short, the last picking being completed by mid-March. The trial averaged 800 lb. seed cotton per acre with a high proportion of stained cotton. The conditions under which the crop was produced tended to level out treatment differences and little reliance is placed on the yield results. In growth, as measured by plant weight, there was definite increase from nitrogen applications.

A similar trial was planted in the second main cotton area in the S.E. of the island. The site was typical of the low rainfall area. Planting was done in late September on a peasant holding but conditions during the month following were dry and the trial was affected by the extensive supplying and weed patchiness. As a fertilizer experiment it was a failure, but the average of 1,400 lb. seed cotton per acre from the plots which got away early and had a fair chance indicates what can be done with reasonable care and cultivation when pest incidence is fairly low.

A third experiment on the volcanic soil failed and for much the same reasons of late get away and patchy growth. These district trials stress the difficulty of experimentation on peasant holdings and the need for control over the site and the various operations. An extended range of these experiments is proposed for the coming season, and it is hoped that the arrangements made will work satisfactorily.

Pen Manure.—An experiment was laid out to investigate the effects of pen manure and artificials over a number of seasons. The layout is of randomized block type and the treatments are :

- (a) No manure,
- (b) 4 tons pen manure per acre,
- (c) 8 tons pen manure per acre,
- (d) 12 tons pen manure per acre,
- (e) Artificials alone equivalent to 8 tons pen manure.

The analysis of the pen manure was received late and the manure proved richer than expected, containing the equivalent of 125 lb. sulphate of ammonia ; 75 lb. 20 per cent. superphosphate ; and 40 lb. sulphate of potash per ton.

The pen manure was applied 4 days before planting and incorporated into the ridges. A portion of the artificials was applied soon after planting but the full amount had to wait the receipt of the analysis and was not applied until 6 weeks later. The crop was planted on September 6th at the common spacing of 2 plants at 2 feet apart on 4-foot ridges. Growth differences were early apparent and samples taken at 4 weeks showed a highly significant increase in all

pen manure treatments. Later observations showed the same growth trend following the amounts of pen manure applied. The average yield was around 1,000 lb. seed cotton per acre but the pest situation tended to level out all except major treatment differences.

All plots receiving pen manure gave significant yield increases—over 30 per cent.—over the unmanured series but the differences between the various rates of application were small. Artificial alone were intermediate in yield but under the circumstances of delayed application the comparison is of little value.

Time of application.—An experiment was designed to investigate the best time of application of artificials. For sulphate of ammonia the times were (a) all at planting, (b) half at planting, and half at thinning and (c) in three parts at planting; thinning; and at first flower; and for superphosphate, (d) all at planting and (e) half at planting and half at thinning.

The conditions of planting, plant establishment and pest incidence were similar to those in the N.P.K. trials and the yields averaged about the same. The experimental error was again high, and neither in growth nor in yield were significant differences found. The only indication from the trial was of the need for phosphate.

Spacing Trial.—A combined spacing, cultivation and fertilizer experiment was carried out on the same soil and under the same planting conditions as the manurial trials. Germination and early growth conditions were good but the subsequent pest attack was high. The average yield was just over 1,000 lb. seed cotton per acre with a high proportion of stained cotton.

The layout was of split plot design with the main plots giving a comparison between no fertilizer and artificials at the rate of 200 lb. sulphate of ammonia, 300 lb. superphosphate and 100 lb. sulphate of potash. The main plots were split into ridge and flat cultivation and these again split into a range of spacings varying on 4-foot ridges from 2 plants at 18 inches to 1 plant at 36 inches. Main results:—

- (a) early growth increase and significantly higher yields from the fertilized plots.
- (b) high significant effect of spacing; the closer spacings showed little differences but were all significantly higher yielding than the widest—1 plant at 36 inches. The spacing aimed at in good cotton cultivation comes within the range of the former.
- (c) no differences in growth or yield between ridge and flat cultivation. Flat cultivation occurs to some slight extent on peasant holdings and on estates where it facilitates the use of implements, but it cannot be recommended from the soil conservation angle except on land of slight slope and with close contours.
- (d) no interactions between treatments were shown.

ROTATION.

During the season trials were laid down to test rotations which might meet the demand for intensification of production and the maintenance of soil fertility.

Rotation Trial A.—The treatments are (1) three crops of cane—plant and two ratoons ; (2) elephant grass for the same period and (3) two cotton crops followed by a complete year in green manure. These treatments will be followed in the fourth and subsequent years by cotton, and will be compared with a fourth treatment of cotton each year. Cane is popular with peasants as a cash crop and has agricultural advantages in reducing erosion losses, particularly when planted in strips, and in providing tops for stock food during part of the year. The grass series meets the need for forage and fertility maintenance when the peasant can be persuaded of the advantage of pen feeding. The periodic rest from cotton growing by a complete year in green manure is practised on some of the better farmed estates in Montserrat, while continuous cotton growing is common practice.

The plots are split to afford a comparison between no fertilizer and a fairly high application of nitrogen and phosphate. The grass is cut at suitable intervals and some information on the economics of the rotations should come to light as production will be measured throughout the term of the trial. Soil moisture determinations are taken at intervals and it is hoped to follow up alterations in structure and fluctuations in soil nitrate.

Rotation Trial B.—A cotton close season of 3 months is enforced by legislation, but in practice the period between the end of the reaping and the next planting may be considerably more. The present investigation is intended to compare various means of handling the land during this period. The treatments are (1) a short-term food crop, either maize or pulse ; (2) a green manure crop ; (3) bare fallow ; and (4) the common practice of a weed fallow. As with the other rotation trial all plots are split into fertilized and unfertilized series.

Some hill land of fairly high slope is available on the Station. The soil is similar to that in the valleys but is thin and stony. The marl deposit is of little depth and limestone often outcrops on the higher elevations. This soil type and slope is fairly extensive and has been under cultivation in the past.

At present much of this land is under low scrub, but considerable amounts have been cleared for cropping by peasants and cultivation of these areas is likely to increase. When cleared the soil soon loses organic matter and erosion can be serious. Trials have been started to see how these slopes can safely be brought into cultivation and productivity maintained by protection measures—contouring and bench terracing—and by strip cropping using cane and grass between the crops more liable to hasten erosion. The effects of green manures and manurial applications are also being observed.

PESTS.

Pink bollworm (*Platyedra gossypiella*) was early seen in the crop. The infestation was a serious cause of loss in some areas and particularly on the Station. The severity of the infestation and its build up during the season were demonstrated on a plot of cotton planted 6 weeks after the main crop. On this not a single clean boll opened. A search of the adjoining bush brought to light a number of abandoned plots with cotton still growing, and these will have served as a source of carry-over of the pest. Experience this season amply demonstrated the seriousness of the pest and underlined the need for a strict observance of the close season and for the intensified campaign now being carried out by the Agricultural Department.

Stainer (*Dysdercus sp.*) was of little consequence as migrants arrived too late to affect the early reaped Station crop. In the volcanic area in the south the crop was established late and the infestation was fairly high.

Nezara viridula.—Considerable loss of early crop on the Station was caused by green bug. It is a fairly common pest of tomatoes and cow peas but its status on cotton is not clear. Wolcott (Economic Entomology of the West Indies) records outbreaks in St. Croix and St. Vincent and records from Montserrat indicate a fairly heavy infestation in some seasons. The adults in many countries are frequently reported as being heavily parasitized by *Trichopoda pennipes* but collections made here, and examined by Dr. Simmonds of the Imperial Parasite Service, have so far shown no parasitism. Further collections will be made next season and the status of the pest examined.

Leaf Worm (*Alabama argillacea*) occurred at different times throughout the season, but lead arsenate spraying gave efficient control.

Other insect pests were of very minor importance—there was some slight loss by *Prodenia* and a few plants at the end of the season showed attack by Leaf Blister Mite (*Eriophyes gossypii*).

FOOD CROPS.

The island is not self-sufficient in food production, the deficiency being made up by importation of flour, salt fish, corn meal and edible oils. The main crops grown are maize and sweet potatoes with some yams and cassava. Legumes, mainly pigeon pea and cow peas, occupy a minor role.

Maize can be grown at any time and the resulting yield is conditioned by the rainfall and by the often heavy attacks by Corn Earworm (*Heliothis sp.*) and by *Laphygma frugiperda*. It is sometimes grown mixed with cotton and other crops.

A fertilizer trial was planted in late October on the valley soil on the Station. The average yield—2,700 lb. cobs per acre—was satisfactory, but treatment differences were slight, the largest increase being 16 per cent. from the combined application of 200 lb. sulphate of ammonia and 300 lb. superphosphate.

A spacing trial was carried out on the $4\frac{1}{2}$ -feet ridges. Three similar plant densities were included—1 plant at 9 inches; 2 at 18 inches; and 1 at 18 inches, but with 2 rows per ridge. The double row arrangement yielded highest, but all these spacings outyielded the wide spacing of 1 plant at 18 inches by over 40 per cent. The result is similar to that found with cotton and indicates the value of close spacing.

PROGRAMME OF WORK FOR 1947-48.

The work will follow the general lines of that described in the present Report.

- (1) Fertilizer trials will be carried out on as many soil types as possible. Investigation of time of application of fertilizers will continue and be extended to include different forms of superphosphate and method of application.
 - (2) The pen manure trials will continue and be supplemented by simple district trials.
 - (3) The rotation experiments, and soil fertility and erosion control trials will carry on into the second year.
 - (4) Observations during the year indicated that poor cultivation is a considerable factor in low yields and cultivation trials will be carried out in addition to those on spacing.
 - (5) Differences in quality of cotton exist between islands growing the same M.S.I. strain but the environmental causes are not clear. Antigua cotton is somewhat coarser and weaker than that grown in Montserrat and St. Kitts and it is proposed to continue investigations by careful sampling under a wide range of conditions.
 - (6) The Sea Island Type Collection will be maintained as in past seasons.
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[Included by courtesy of the Government of the Leeward Islands.]

COTTON BREEDING STATION—MONTSERRAT.

PROGRESS REPORT FOR THE YEAR 1947

BY

A. S. HARPER.

GENERAL INFORMATION.

	<i>Island Crop.</i>	<i>Breeding Experiments.</i>
Normal Sowing Dates	1st March—31st May	1st March.
Normal Picking Dates	July—October	Beginning of July to mid-August.
Legal Close Season	December, January, February ...	—

The dry weather at planting time this year caused the planting period to be prolonged to 14th June, and the beginning of the Close Season to be delayed until 15th December. The breeding experiments were planted on 16th March and the reaping period extended from 23rd July to 10th September.

METEOROLOGY.

The rainfall for the cropping period was low. Figures for the Station, Bethel on the windward side of the island, and Brades in the north, are given below. Rainfall for the same period at the Station was 55.94 inches in 1945 and 41.29 inches in 1946.

	<i>Mar.</i>	<i>April.</i>	<i>May.</i>	<i>June.</i>	<i>July.</i>	<i>Aug.</i>	<i>Sept.</i>	<i>Oct.</i>	<i>Totals.</i>
	<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>
Cotton Breeding Station ...	1.68	1.63	5.37	2.12	4.56	3.28	10.93	7.92	37.49
Bethel	0.60	0.97	5.11	1.62	2.48	1.87	11.93	10.53	35.11
Brades	1.46	1.53	5.66	1.82	3.83	3.31	9.44	4.62	31.67

The unfavourable weather conditions, coupled with Black Boll and Pink bollworm attack in parts of the island, reduced the average yield of lint per acre in the island this year to 107 lb.

COTTON BREEDING WORK.

Main Breeding Trial.—The main breeding trial consisted of twenty non-replicated progeny rows, the highest yielding two plants being selected from the following ten of the previous year's progenies—M.4601, M.4602, M.4611 to M.4617 and M.4619. Each of these selected plants was used to plant a progeny. Selfing of this material was carried out as usual.

Differences were again small. Progenies M.4702, M.4704 and M.4719 gave low values for lint per boll, and the ginning outturn of progeny M.4702 was unexpectedly low. Progenies M.4701 and M.4720 gave comparatively low seed weights.

Small Bults Trial.—This trial included ten bulks, each of which comprised the seed remaining from the two selected plants of each of the previous year's selected progenies. Before this year, bulks had been formed from the seed of not merely the selected two plants but of all fifty of the plants grown in the selected progeny rows in the previous year. The reduced amount of seed available under the new system was insufficient to plant the usual area, and the size of the plots, each of which contained twenty plants, was reduced to one-third of the normal.

Data for the Small Bults Trial are given in the following table.

1942 Ancestor.	1946 Progeny.	1947 Bulk.	Ginning Outturn.	Seed Weight per 100 seeds. gms.	Lint Index. gms.	Lint per acre. lb.
M.4208	M.4601	M.B.4701	30.62	14.51	6.42	636
"	M.4602	M.B.4702	30.92	14.85	6.64	675
M.4210	M.4611	M.B.4711	30.61	14.21	6.28	650
"	M.4612	M.B.4712	30.05	14.20	6.12	587
M.4213	M.4613	M.B.4713	31.51	13.98	6.39	714
"	M.4614	M.B.4714	31.10	14.11	6.26	658
"	M.4615	M.B.4715	31.22	13.80	6.25	692
"	M.4616	M.B.4716	31.31	13.70	6.22	705
"	M.4617	M.B.4717	30.75	13.70	6.09	675
"	M.4719	M.B.4719	31.06	13.84	6.22	682
		Means	30.92	14.09	6.29	667.8

Statistical analysis of the data revealed significant differences between bulks for every character except lint yield. These were shown to be due to differences between the various family groups M.4208, M.4210 and M.4213, and even in lint yield significant differences were detected between these groups. There were no significant differences within each family group.

Descendants of M.4213 have remained superior in yield, while this season their ginning percentages were highest and their seed weights lowest. Their lint indices were intermediate. Descendants of M.4208 combined their usual high seed weights and lint indices with intermediate yields, and bulks descended from M.4210 were characterized by comparatively low yields and ginning outturns.

SPINNING TESTS RESULTS.

Spinning test reports on the 1946 progeny material were received during the year. Most of the samples were similar to each other in yarn strength and appearance. M.4601 and M.4612 were a little below the average in strength and M.4612 was also poor in appearance. M.4602, M.4613, M.4614 and M.4619 were among the strongest and M.4602, M.4613 and M.4614 among the best in appearance.

Among the samples collected from various ecological areas in the island differences were more marked, but could not be ascribed to any particular factor—soil type, yield or rainfall.

SELECTION FOR 1948.

Progenies M.4701 and M.4702, both selected from progeny M.4601, and progenies M.4707 and M.4708, selected from M.4612, will be discarded on account of their low yields and unfavourable spinning test reports. All other progenies will be carried on.

MULTIPLICATION OF SELECTED SEED.

After single plants had been selected for planting this year's progenies and small bulks, the remaining selfed seed from the selected progeny rows was mixed to plant the four acre multiplication area at the Grove. Weather conditions were unfavourable, and the average yield was lower than usual. From the pedigree seed of the previous year one hundred acres were established at Richmond, and seed from this area forms a large part of the supply in the Government Seed Store for planting the 1948 crop.

Distribution of M.S.I. Seed.—The following quantities of pedigree seed were supplied to other islands of the Leeward group :—St. Kitts 150 lb., Antigua 170 lb., Nevis 300 lb. In addition 3,000 lb. of ordinary planting seed were shipped to Antigua, 40 lb. to British Honduras, and a small quantity to the University of Tennessee.

EXPERIMENTS.

N.P.K. Experiments.—The N.P.K. trials on the four main soil types in the island were continued, but only in the case of the trial on Richmond Fresh Ash soil was a crop obtained. On the other soils the crop suffered very badly from adverse weather conditions and insect pest attack, and yields were insignificant.

On Richmond Fresh Ash soil, the lower level of application of nitrogen gave an increase in yield of 15%, amounting to 273 lb., of seed cotton over the control, the differences falling just short of statistical significance. This increase in yield, with the price of lint at 60 cents a lb., would yield a profit of about \$30.00 an acre to the grower, after expenses of manuring were deducted. Last year, differences were observed while the plants were growing, the nitrogen plots looking greener than the non-nitrogen plots. Boll shedding occurred and it appeared that the plants in the nitrogen plots, which were carrying the greatest number of bolls, were less able to withstand the drought conditions, as they shed more bolls. No potash applications were made to any plot this season. Yields of plots treated with superphosphate were slightly below those of control plots and decreased with the increasing dose of superphosphate.

Rotational Cropping Trial.—A rotational trial to compare the different systems of cotton growing has been started on the Otway Land Settlement. The treatments comprise (a) cotton grown annually with a weed fallow in the close season and (b) cotton grown annually (except for a green manure crop for a complete year at intervals) with a bare fallow during the close season. Both these systems are at present practised in the island. In view of its value to the land and its possibilities as a subsidiary economic crop, cane is included in a third treatment (c) a cane, cotton, food and green manure rotation. Cane is to occupy the land from January, 1948, to May 1950, giving a plant and one ratoon crop, food and green manure are to be grown to April, 1951 and then three crops of cotton are to be followed by a year of food and green manure, thus completing a seven year rotation in October, 1954. The fourth treatment (d) is similar to (c) but cane is replaced by a soiling grass, in this instance Elephant grass, in view of its value as food for penned animals, in erosion control and general improvement in soil fertility.

Planting Date Experiment.—At the Grove Botanic Station a trial in four randomized blocks was laid down to ascertain what control over insects could be secured, without adverse effects on the plant, by the application of selenium at various rates. The potential use of the method was to enable a comparison to be made between the cropping potentials of cotton planted at different seasons. The treatments comprised (1) no selenium (2) selenium applied at the rate of 3 lb. an acre to the soil every ten days from the time when the plants were about five weeks old, and (3) selenium applied as in (2), but at the rate of 6 lb. an acre at each application. After four applications had been made bracts showed signs of reddening due to absorbed selenium, and no further applications were made. A count for pink bollworm infestation on ripened bolls was taken and yield data were recorded. These were as follows :—

								% of Bolls infested with Pink Bollworm.	Yield of Lint.
Control	...	...	...	...	...	...	...	5.77	222
Treatment I	...	...	...	...	...	...	...	3.28	178
Treatment II	...	...	...	...	...	...	...	2.29	223

Pink bollworm infestation was not high on the control plots, and, while there was a reduction of infestation on the selenium treated plots, complete control was not obtained. There were no significant yield differences to be ascribed to the selenium treatment.

Acknowledgment.—The writer wishes to acknowledge the advice and direction of Mr. J. V. Lochrie, O.B.E., Cotton Officer, West Indies, and to thank officers of the Agricultural Department and planters who assisted in the work.

PROGRAMME OF EXPERIMENTS FOR 1948.

Breeding.—The breeding and seed multiplication will be continued on the lines of the past year.

Field Experiments.—

1. The N.P.K. trials on major soil series will be continued with the addition of one simpler trial on shoal soil.
2. The rotational trial outlined above will be continued.
3. Pen manure trials will be continued.

[Included by courtesy of the Government of the Windward Islands.]

PROGRESS REPORT
ON THE
COTTON BREEDING WORK
AT
CAMDEN PARK EXPERIMENT STATION, ST. VINCENT,
FOR THE SEASON 1946-47.

BY

W. R. E. NANTON.

GENERAL INFORMATION.

	<i>Island Crop.</i>	<i>Experiments.</i>
Sowing dates	15th August to 30th September ...	17th to 20th September.
Picking dates	December to February.	—
Legal Close Season	1st May to 15th August	—

WEATHER CONDITIONS.

Weather conditions at planting were favourable and a near-perfect stand was obtained in all experiments. The season generally was characterised by dull rainy weather during the first four months of growth. In spite of the early appearance of Pink bollworm, a fair crop, averaging 250 lb. lint per acre, was reaped over the multiplication fields, but the experiments, planted later, were badly affected by the pest, and very poor yields were obtained.

BREEDING PROGRAMME.

The breeding programme carried out may conveniently be discussed under three heads :—

- (a) The V-135 seed renewal scheme,
- (b) Work with VH hybrid material, and
- (c) Maintenance of variation plots.

V-135 Seed Renewal Scheme.—The selection of plants from self-fertilized progeny rows of V-135 cotton is now largely a matter of routine. During the season, sixteen progeny rows were carried on from sixteen selected plants from the 1946-47 breeding material.

This year lint samples from every row were submitted to the Shirley Institute for small-scale spinning and hair tests, but the results of these are not yet available. Selection of parents was therefore based on the characters which could be measured locally. For purposes of record these plants, with the designations of their parents, are given in Table I:—

TABLE I.
SELECTIONS FROM V-135 PROGENY ROWS 1946-47.

Selected Progeny.	1945 Parent.		Strain.	Selected Plants.
	Progeny.	Plant.		
V.4626	V.4526	10	V(30)46	Nos. 5, 6, 8
V.4629	V.4531	8	"	" 1, 10, 12
V.4632	V.4534	15	V(37)11	" 2, 6, 9
V.4636	V.4536	7	"	" 3, 12, 19
V.4638	V.4538	3	"	" 8, 15, 20

In addition to the above plants, 30 plants selected from 10 other V-135 progenies were carried on in reserve progeny rows to provide replacements in the event of spinning tests revealing undesirable progenies, which, for lack of information as to spinning behaviour, had been selected as parents for the main breeding plot.

All selfed seed not required for the 1946-47 progeny rows was planted at Camden Park for seed increase; the contributing progenies were bulked to give a total yield of 1,333 lb. seed for further multiplication.

Second stage multiplication of cotton seed for planting during the season under report was carried out partly at Diamond Estate, and partly at Camden Park. From these two sources, 30,394 lb. of seed were set aside and treated with corrosive sublimate for commercial planting in 1947.

Work with VH Hybrid material.—The programme of selection for the VH breeding material comprised two trials, viz. the main VH breeding trial and the VH small bulk trial. The main trial took the form of a 3(5 × 5) Lattice Square experiment with a plot of 8 plants, sown four on each of two 4-foot ridges, to give a plot 8 feet × 8 feet. Twenty-four progenies were tested, all belonging to the genotype known as VH8 which more closely resembles V-135 than do any of the others. These progenies may be grouped into families as shown in Table II. In addition, one V-135 progeny was included for comparison.

In the small bulk trial, the same families that contributed to the main breeding trial were tested in plots of 1/240 acres in area. In this trial two blocks, planted late, failed, and the statistical analyses were carried out on four blocks only. The usual yield and seed cotton characters were measured and estimated in both trials, and summaries are given under Table II.

TABLE II.
SUMMARY OF DATA—VH TRIALS.
1946-47.

Strain.	Family.	Lint per plot (Main Breeding Trial).	Lint per plot (Small Bulk Trial).	Ginning Out- turn.	Seed Weight.	Lint Index.	Bolling Index.	Seeds per boll.
		gm.	gm.	%	gm.	gm.	arb'ry.	
VH.4403	VH.4502	618	1,541	29.73	12.9	5.5	756	14.9
	VH.4503	587	1,511	29.09	12.2	4.9	752	15.6
	VH.4504	557	1,789	29.34	12.7	5.3	701	15.1
Mean	...	581	1,610	29.39	12.6	5.2	736	15.2
VH.4407	VH.4505	366	1,579	26.00	12.4	4.4	566	15.0
	VH.4506	477	1,520	27.17	12.7	4.8	687	14.7
	VH.4507	438	1,289	27.49	12.2	4.7	639	14.8
Mean	...	427	1,463	26.89	12.4	4.6	631	14.8
VH.4409	VH.4508	509	1,860	27.86	12.5	4.8	640	17.1
	VH.4509	548	1,745	27.31	12.6	4.7	724	16.1
	VH.4510	581	1,608	27.26	12.1	4.5	760	17.1
Mean	...	546	1,738	27.44	12.4	4.7	708	16.8
Mean, all VH Progenies	...	520	1,605	27.92	12.5	4.8	692	15.6
	V-135	421	1,311	25.15	12.5	4.2	691	14.3

Analysis of both trials revealed that families VH.4505, 4506 and 4507, which together made up strain 4407, were inferior in yields to the other two strains under trial. Moreover, spinning tests on the previous year's material indicated that this strain produced the weakest yarn of all the VH.8 types. It was therefore decided to discontinue selection work on this strain.

As the results of spinning tests on the current season's material were not available at the time of making up the new season's trials, all selections were based on the 1945-46 spinning data. These tests had brought to light four progenies whose yarn strengths closely rivalled V-135. In the small bulk trial, the descendants of three of these families, viz. VH.4508, 4509 and 4510, were among the best four bulks, not differing significantly among themselves as regards yield of lint. The fourth, 4502, was not significantly inferior to the second best. This last, however, gave two outstanding progenies in the main breeding trial.

Selection of parents for the 1947-48 trials was therefore made from these four families only, the main effect of this being to eliminate from the VH breeding material all progenies which did not closely resemble V-135 in spinning behaviour. Twenty-four plants were therefore selected for further trial from six progenies belonging to these families.

Maintenance of Variation Plots.—At the commencement of the season, the material for the Sea Island Type Collection was sent to the Cotton Station at Antigua for maintenance there. The variable bulk collection was maintained during the year at this station.

PROGRAMME OF WORK FOR 1947-48.

- Breeding.* (1) V-135 progeny row non-replicated trial.
(2) VH.8 main breeding trial.
(3) VH.8 progeny rows.
(4) VH.8 small bulk trial on poor land.
(5) Production of bale of VH.8 cotton for brokers' valuation.
- Field Experiments.* (6) High level manurial trial with cotton.
(7) Rotation trial with catch crops, green manure, and grass fallow.
-

EMPIRE COTTON GROWING CORPORATION

1a, Harrington Road, South Kensington, London, S.W.7.

List of Publications issued to date. Those still in print can be obtained direct from the Corporation at the above address. Those out of print are marked with an asterisk. The prices include postage.

GENERAL AND TERRITORIAL

- "Cotton Growing within the British Empire and the World's Capacity for Consuming Cotton Goods." J. W. McConnel. 1921. Price 2s.
- * "Cotton Growing in Nigeria." Sir Hector Duff. 1921.
- "The Extension of Cotton Cultivation in Tanganyika Territory." Major Hastings Horne. 1922. Price 2s.
- * "Cotton Cultivation in Nyasaland." H. C. Sampson. 1922.
- * "Cotton Growing within the British Empire." L. G. Killby. 1924.
- "Cotton Growing in South Africa." G. F. Keatinge. 1925. Price 2s.
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